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THE ANNEALING OF FLAT GLASS

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By F. W. PRESTON

Abstract

Continuing his researches on the annealing of flat glass, the author in this first part of his new study shows, to begin with, that density is the physical property which best characterizes the structural state of the glass; then he determines, as a function of the temperatures in the transformation range, the curves of equilibrium values of density of an ordinary crown glass and, for each of these temperatures, the curves giving the variation of density and of birefringence as a function of time.*

The author shows by typical examples how it may be dangerous to take into consideration in the use of glass only its residual birefringence, apart from its degree of stabilization as indicated by density.

Introduction

In the following lines we wish to examine some logical consequences that flow from our present knowledge of the question of "annealing" and to support them by a series of experiments.

Up to the present time in a great majority of cases, glass has been regarded as well or poorly annealed according to whether it shows a greater or less birefringence at room temperature. Therefore, if we had a sufficiently detailed acquaintance with the process by which this birefringence is developed, we should be in a position to eliminate it straightforwardly in an annealing operation.

On this subject there are two opposing interpretations: the first, that of Adams and Williamson[1] (1920) which we may call the purely mechanical concept; the second, that of A. Lebedeff[2] (1921) which is a structural concept.

It is interesting to note in this regard that the work of Lebedeff which is commonly cited[2a] (1926) is not the first pronouncement on the structural concept, but is a later development in which Lebedeff does not again mention a whole series of important facts since he considers them to be well known.

The two concepts were set forth and published within a month of each other, but while that of Adams and Williamson received a warm welcome in industry and was rapidly accepted, that of Lebedeff has remained comparatively unknown, although it did provoke laboratory work in various countries. It did not achieve immediate application until the time when Madam Winter Klein[3] (1936 onward) took it up and attempted to apply it to current practice.

The mechanical theory is seductive in its simplicity. According to Adams and Williamson, it permits us to predict during an annealing cycle the variation of birefringence as a function of thermal treatment, based on a few formulae in which numerical values of the different physical constants are taken into account. Its weak point is in considering these physical characteristics for any given glass as a unique function of temperature and not equally a function of time.

As a matter of fact, on the contrary, the criterion of lack of birefringence does not permit us to deduce the physical characteristics of the glass, for birefringence merely indicates the difference of index of refraction in the interior and on the surface of the fragment of glass under examination.

(*Note by translator:* This is what Daragan says, but it does not seem to me to be a very straightforward or even accurate statement. Its meaning becomes clear from what follows later.)

The structural theory, on the other hand, would explain the appearance of birefringence by the difference of specific volumes of the glass in the interior and on the surface and, furthermore, permits us to describe the structural state of the glass by a reference to its equilibrium curve.

This theory, born in 1921, was confirmed by a number of works bearing on a variety of physical properties of glass[4] (1931 through 1948), but its application to the annealing of ordinary glass does not seem to have been studied in the detail accorded to the annealing of optical glass of high quality.

Having carried out a series of tests of the annealing of

* See Verres et Refractaires, April 1950, pp. 73-82.

a variety of glasses, and having demonstrated that birefringence measured at room temperature was connected with the structural effect[5] (1950), we have undertaken to study concurrently, on a single glass, the variation of birefringence and the evolution of structural state, in order to try to define annealing not in terms of the birefringence which appears after the glass has been completely cooled, but by some property that belongs to the physical structure of the glass, that is to say, some quantitative and reproducible property.

The first part of this work involves our establishing, first, the characteristics that define structural state of the glass and, secondly, curves of release of stress.

The second part will deal with the definition of states characteristic of present-day flat glass and the influence of the rate of cooling on the birefringence observed, whether we start with a particular structural state or with a specified program of relaxation.

PART I*

Structural State and Release of Stress

Section 1. General

According to the structural theory, every glass possesses a transformation range which extends some distance up and down from the volumetric transformation point (denoted by Daragan "θ_{tr}"). (*Translator's note:* I have used the term "volumetric" transformation point to mean simply the transformation point indicated by a thermal expansion curve. Most often the expansion is measured linearly rather than volumetrically, but I needed a short term.) By transformation temperature we mean the temperature corresponding to the point of intersection of the two substantially straight segments of the expansion curve when "produced," the one above and the other below the "elbow" which joins them. The expansion curve is determined on rods some 3 or 4 mm. in diameter, heated at an average rate of 3°C. per minute.

In this transformation range, to each temperature θ_1 there corresponds a well-defined equilibrium state E_1. If we start with glass at another temperature, θ_2, which therefore belongs to another equilibrium state, E_2, it moves toward the equilibrium state E_1 with a speed which is larger in proportion as E_2 is more removed from E_1, and in proportion as the temperature is higher (Lebedeff, Winter Klein, Stojaroff[5a] (1928), Gillod[6] (1949), Douglas and Jones[7] (1948), Douglas[8] (1947), etc.).

What is involved therefore is a study of two quantities in the transformation range: the equilibrium value at a given temperature of the characteristic we choose, and the rate at which this characteristic of the glass, initially at some other temperature, tends towards this equilibrium value.

Two methods permit a simultaneous study of these phenomena: the first consists in following the variation of a characteristic at high temperatures (Lebedeff, Lillie, Winter Klein, Gillod); the second, which is a "stereotypage," or "freezing-in" technique, involves bringing the specimen down to room temperature by a specified but more or less violent quenching after it has undergone a thermal treatment (Lebedeff, Winter Klein, Florinskaya, Gillod, Douglas).

The freezing-in technique undoubtedly involves a small amount of systematic error, especially towards the higher temperatures, but it does offer a very easy method of experimenting. This ease of experimenting is the reason that we have chosen it, for the error that it introduces becomes apparent only in a range of temperature situated above the volumetric transformation point, and this is a region of relatively little interest in practical annealing.

A number of physical characteristics could be used to define the structural state of a glass, such as the refractive index, Young's Modulus, thermal expansion, electrical conductivity, chemical resistance, or density. From the point of view of the experimentalist, the two characteristics which lend themselves best to such a study are the index of refraction and density.

We ourselves have used density determinations. Variations of refractive index are not only subject to variation with specific volume but also to changes of molecular refraction of the constituent oxides in direct proportion as the complete glass becomes more dense, and these latter changes move in the opposite direction from variations of refractive index of the glass as a whole. Therefore, if a reduction of the specific volume tends to increase the refractive index, the molecular refraction tends to lessen it: it therefore comes about that the net increase is not as large as it would be if it were produced solely from a variation of specific volume.

Kreidl[9] (1950) gives, for a borosilicate quenched and annealed at 532°C., a difference of density of 1.1% and a difference of refractive index of 0.35%.

On some glasses that were tested in the "Prover" Laboratories, we took glass that had been chilled from a temperature of θ_{tr} +150°C. and annealed at θ_{tr} —50° and were able to obtain the following variations:

	Density	*Refractive Index*
Dense barium crown...	1.3 %	0.45%
Borosilicate	1.3 %	0.2 %
Dense flint	0.40%	0.12%
Ordinary crown	0.5 %	0.13%

Douglas and Jones[7] (1948) showed that the variations of density likewise undergo two contrary actions: one which increases and the other which diminishes it, but these two variations in opposite directions are produced

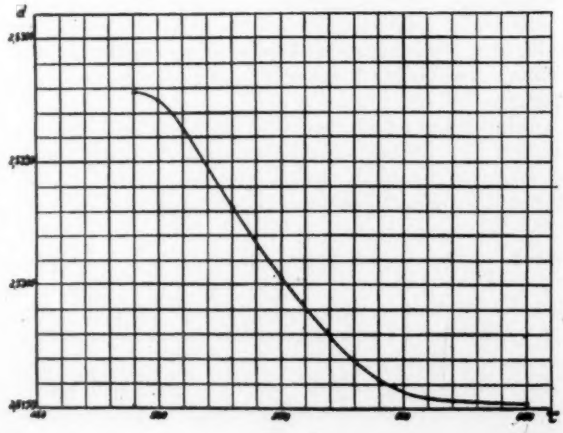

Fig. 1.

* The original French paper will be continued in Verres et Refractaires.

at different rates and are of different orders of magnitude so that at the beginning of a stabilization at fixed temperature, this latter being within the transformation range, we first observe a rather important increase of density followed by a very slow decrease. This latter diminution continues indefinitely within the practical time limits of experimentation (a thousand hours or so).

In our tests we have chosen density as an index of structural state and have taken as the equilibrium value for practical purposes the highest value it attains.

Section 2. Experimental

Tests were made on ordinary crown having the following composition and properties:

Analysis by weight	
SiO_2	72.00
Na_2O	14.00
CaO	12.00
MgO	0.10
Al_2O_3	1.00
Fe_2O_3	0.05
SO_3	0.55
	99.70

Thermal Expansion by °C.	
0 — 200°	87 x 10^{-7}
0 — 300°	92 x 10^{-7}
0 — 400°	96 x 10^{-7}
Transformation point	550°C.
Softening point from transformation curve	580°C.

The method of measuring the release of internal stresses by the reduction of birefringence was the same as in our preceding work[5] (1950).

The rate at which equilibrium density was approached was measured as follows: Some 100 specimens 6 x 6 x 6 mm., cut from a block of glass, are checked for density with the aid of the Preston Sink-Float apparatus after all of them had been annealed together with a view to putting all of them in the same structural state.

On the basis of the Sink-Float results, we choose from this collection those specimens whose "transit temperatures" do not differ by more than 0.08°C., which corresponds to an absolute density value which does not differ by more than 0.0001 at the most. Then each specimen is quenched separately from a temperature somewhere between 650° and 490°C. by taking it out of the furnace into the open atmosphere. After this quenching the specimens are once again tested in the Sink-Float and there are chosen for later tests only those whose transit temperatures do not differ by more than 0.04°C. This double Sink-Float test is intended to sort out those specimens which are homogeneous from the point of view of composition and, further, to assure that we begin our test with specimens of the same composition and the same structural state.

Knowing now the density of the specimen at the beginning, we introduce it in a furnace of high heat capacity which is maintained at constant temperature within about ± 0.5°C. After a specified lapse of time, the specimen is taken out and "Sink-Floated." This operation is repeated, for each specified temperature and for longer and longer time intervals, until the density becomes constant or begins to diminish. If a diminution is encountered, the maximum density is considered to be the equilibrium value.

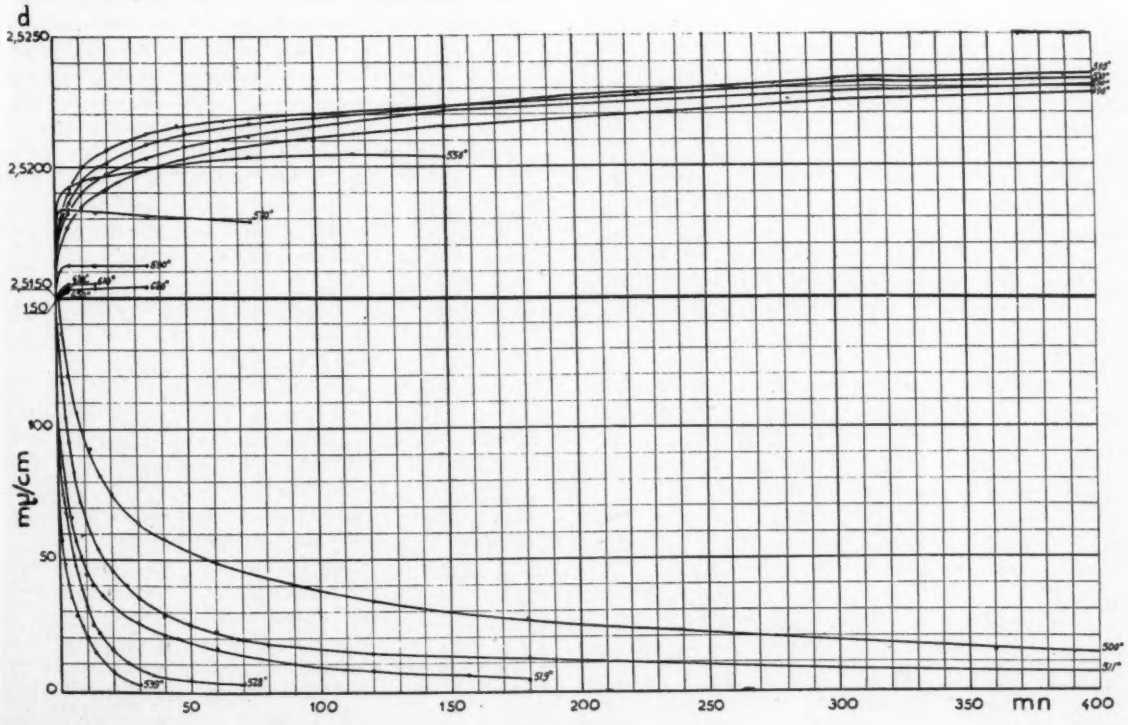

Fig. 2.

TABLE I

Equilibrium Density

650°C.	2.5152
630°C.	2.5153
610°C.	2.5155
590°C.	2.5162
570°C.	2.5180
550°C.	2.5204
530°C.	2.5232
510°C.	2.5264
500°C.	2.5275
490°C.	2.5278

In Table I there are indicated these equilibrium densities, and Figure 1 presents the result in the form of a curve. In Table II are given the numerical values from which the curves of rate of attainment of equilibrium density can be graphed. In Table III are listed the numerical values from which the curves of rate of stress release can be drawn.

Figures 2 and 3 give, on the one hand, curves of rate of stress release and, on the other, curves of density variation as a function of time at various constant temperatures; Figure 3 is an enlargement of part of Figure 2 dealing with the first two hours, which is the region of most immediate interest to glass manufacturers.

Section III. Discussion and Interpretation

The curve of Figure 1 confirms once more the fact, noted by various authors, of the existence of a transformation region extending on either side of the volumetric transformation point, and further, it gives us a means of defining the state of a particular glass, not merely by a change in birefringence, but by a very definite quantity, the numerical value of a physical constant, namely, density. What is more, the absolute value of the density, which is affected by heterogeneity from the manufacturing process, does not affect the result if we base our reasoning as Gillod has already proposed (in a Conference at Charleroi on December 11, 1950, at the time of the meeting held under the auspices of the Continental Scientific Glass Union) on density differences. For instance, if we consider the curve of Figure 1, we may verify the fact that the glass, stabilized at high temperature and then brought to room temperature swiftly, possesses the equilibrium density of 2.5152; the same glass, stabilized at a low temperature for 610 hours and equally swiftly brought to room temperature, has a density of 2.5278. The difference of 0.0126 would correspond to a "stabilization" (annealing) of 100%. Nevertheless, the glass in question as received from the factory has a density of 2.5203, lower than the density of perfectly stabilized glass by 0.0075, which would represent a stabilization of 59.5%. Results of tests of this sort on industrial glasses will be published in the second part of this article.

One may object to this method of operating on the grounds that the experimental time lapse needed to determine the lower point (of temperature) on this curve is too long. But here it appears to us that we must consider practical requirements even though it may involve some slight distortion of scientific accuracy. For modern glass which is placed on the market with a birefringence of from 20 to 70 millimicrons per centimeter, depending on the method of manufacture, it is of little consequence to undertake annealings of an extravagant kind such as those, for example, which would permit us to obtain the maximum equilibrium density. On the other hand, we have been able to verify experimentally that the lower limit of the transformation range is located, on the scale

TABLE II

Extra-White Boussois Glass Density

650°C.		100 min.	2.5220	150 min.	2.5221
5 min.	2.5152	150 min.	2.5223	300 min.	2.5228
		225 min.	2.5227	450 min.	2.5233
630°C.		300 min.	2.5231	600 min.	2.5237
5 min.	2.5154	450 min.	2.5232	945 min.	2.5243
		600 min.	2.5229	1500 min.	2.5249
610°C.				2040 min.	2.5252
5 min.	2.5155	**510°C.**		3000 min.	2.5257
15 min.	2.5155	5 min.	2.5186	4500 min.	2.5259
		10 min.	2.5193	6060 min.	2.5263
590°C.		20 min.	2.5202	9000 min.	2.5269
5 min.	2.5162	35 min.	2.5209	11880 min.	2.5269
15 min.	2.5162	50 min.	2.5212	16220 min.	2.5271
35 min.	2.5162	75 min.	2.5216	21600 min.	2.5275
		100 min.	2.5218	26100 min.	2.5274
570°C.		150 min.	2.5223		
5 min.	2.5183	300 min.	2.5232	**490°C.**	
15 min.	2.5182	600 min.	2.5241	5 min.	2.5176
35 min.	2.5181	900 min.	2.5244	10 min.	2.5184
75 min.	2.5179	1500 min.	2.5248	20 min.	2.5192
		2040 min.	2.5250	35 min.	2.5199
550°C.		2880 min.	2.5252	65 min.	2.5206
5 min.	2.5192	4140 min.	2.5257	100 min.	2.5210
15 min.	2.5195	5640 min.	2.5260	150 min.	2.5215
35 min.	2.5199	7140 min.	2.5264	300 min.	2.5225
75 min.	2.5203	8640 min.	2.5261	645 min.	2.5235
115 min.	2.5204	9490 min.	2.5259	1200 min.	2.5243
150 min.	2.5203			2100 min.	2.5250
		500°C.		3300 min.	2.5253
530°C.		5 min.	2.5182	4800 min.	2.5258
5 min.	2.5190	10 min.	2.5190	7800 min.	2.5264
10 min.	2.5199	20 min.	2.5197	10800 min.	2.5274
20 min.	2.5206	35 min.	2.5203	15000 min.	2.5269
35 min.	2.5212	50 min.	2.5207	21600 min.	2.5272
48 min.	2.5215	75 min.	2.5212	25200 min.	2.5273
75 min.	2.5218	100 min.	2.5215	29700 min.	2.5274
				36600 min.	2.5278

TABLE III

Stress Release

539°C.			**519°C.**			40 min.	28.4	"
1 min.	57	mμ/cm	1 min.	95.5	mμ/cm	50 min.	25.4	"
2 min.	48	"	2 min.	79.6	"	60 min.	22.8	"
3 min.	40	"	4 min.	69	"	80 min.	17.5	"
4 min.	35	"	6 min.	57	"	120 min.	13.5	"
5 min.	31.2	"	8 min.	50.8	"	180 min.	11	"
6 min.	28.8	"	10 min.	44.4	"	300 min.	7.25	"
8 min.	24.6	"	12 min.	41	"	480 min.	3.4	"
10 min.	20	"	16 min.	36.2	"			
14 min.	14	"	20 min.	31.6	"	**500°C.**		
20 min.	6.75	"	30 min.	25.1	"			
30 min.	2.1	"	40 min.	20	"	1 min.	150	mμ/cm
			60 min.	15	"	2 min.	136	"
528°C.			90 min.	10	"	4 min.	120	"
1 min.	86	mμ/cm	120 min.	7.65	"	8 min.	105	"
2 min.	75.2	"	180 min.	3	"	12 min.	92.5	"
3 min.	68	"				16 min.	82.0	"
4 min.	56	"	**511°C.**			20 min.	75	"
5 min.	51	"	1 min.	134	mμ/cm	30 min.	64	"
6 min.	47.4	"	2 min.	117	"	40 min.	57	"
8 min.	38.4	"	3 min.	104	"	60 min.	49	"
10 min.	31.4	"	4 min.	95	"	90 min.	40	"
12 min.	25.4	"	6 min.	83.5	"	120 min.	34	"
15 min.	21	"	8 min.	75	"	150 min.	30.4	"
20 min.	15.6	"	10 min.	66.5	"	180 min.	27	"
25 min.	10.55	"	15 min.	53.5	"	240 min.	22	"
36 min.	6.8	"	20 min.	46	"	360 min.	14.8	"
50 min.	4.2	"	25 min.	40	"	450 min.	11.8	"
70 min.	2.54	"	30 min.	35	"	990 min.	3.8	"

of temperature, some 50° lower than the volumetric transformation point. This observation has been made on sodium-calcium glasses, sodium-potassium-calcium glasses, borosilicates and dense barium crowns, as well as for extra dense crowns. When determining the equilibrium density at more elevated temperatures, and therefore going faster, say some 30 to 40°C. below the transformation point, and considering a "practical" amount of stabilization, this will be quite sufficient.

On the other hand, instead of defining the annealing in terms of birefringence, the glass will be defined by its position on the equilibrium curve. Knowing, for example, the density of such a glass as placed upon the market, it would only remain to determine, by means of the curves in Figures 2 or 3, the schedule to follow in order to attain as rapidly as possible the density specified in advance.

Examination of these curves allows us to draw immediately some very useful conclusions and to confirm once more that: (a) a specified density can be reached by stabilizations carried out at different temperatures, but it is the stabilization at the highest temperature which leads most quickly to the desired result; (b) the rate of stabilization is greater in proportion as one starts from a state more distant from the equilibrium value; (c) between these two factors (temperature of stabilization and distance from the equilibrium value) influencing the rate of stabilization, it is temperature which is the controlling factor.

It seems useful to us to illustrate this last point by a very simple numerical example, without appealing to mathematical equations or complicated calculations.

Consider, for example, the curves of rate of attaining equilibrium at temperatures of 530°C. and 490°C. Let us suppose (see Table II) that when we operate at a temperature of 530°, where the equilibrium density is 2.5232, we have compacted the glass to the value 2.5223, which would take us about 150 minutes. In order to arrive at a density of 2.5231, very close indeed to the equilibrium value, we shall need another 150 minutes for a change of 0.0008.

By interpolation, we see that we should need 19 minutes to change the density by 0.0001. On the other hand, if we worked at a temperature of 490°, we reach the same density of 2.5223, which is very far removed from the equilibrium density of 2.5278, after 280 minutes. In order to progress by the same 0.0008, so as to arrive at a density of 2.5231 as in the previous instance, we still need an additional 225 minutes, which amounts to 28 minutes for an increase in density of 0.0001.

Conclusion (c) is of the greatest importance in carrying out a rational thermal treatment in its later phases, that is to say, during the cooling process intended to take the glassware from the stabilization temperature down to room temperature.

It is obvious that cooling in the absence of a thermal gradient involves no birefringence and the glass, while it possesses the desired degree of stabilization, shows no double refraction.

Since cooling without a thermal gradient is impossible, the final result will be a compromise between several factors, more particularly between the thermal gradient and the structural gradient (Daragan: 1950). It seems to us that this point is no longer in doubt. Lebedeff[2] (1921)

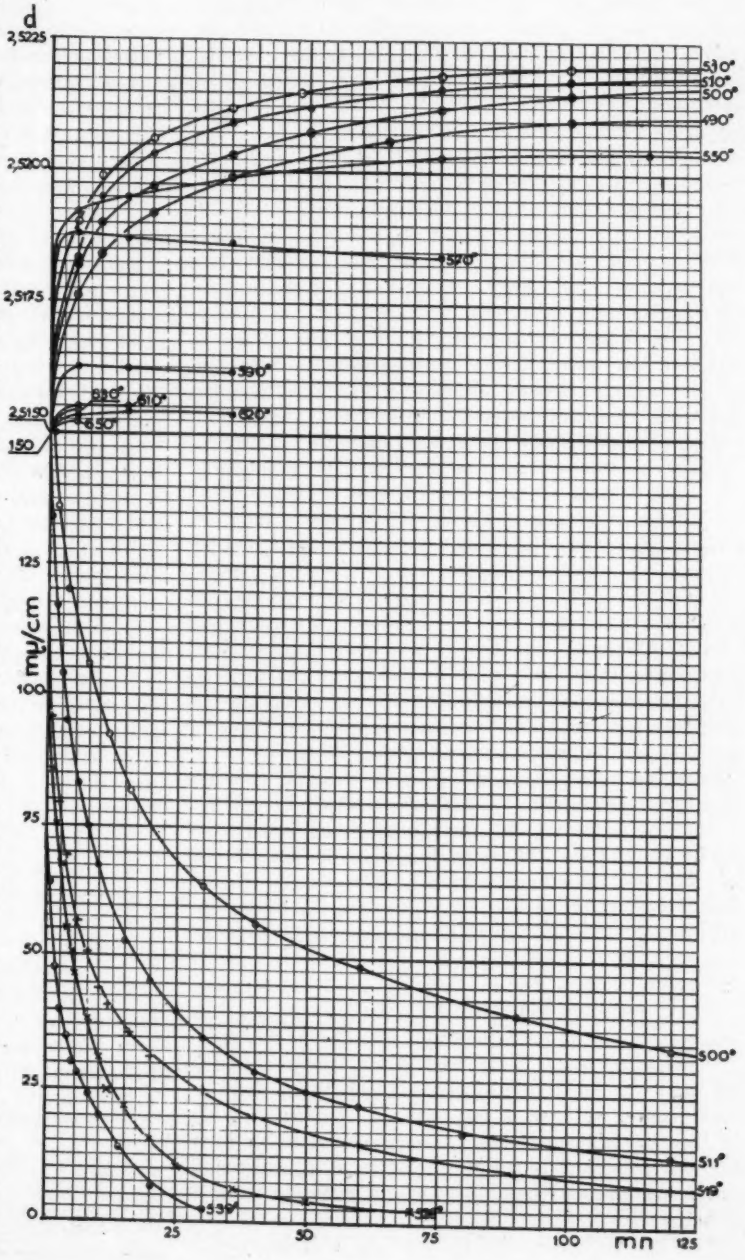

Fig. 3.

has shown experimentally that an irreversible birefringence appeared in glass perfectly annealed when the glass, whose temperature was being steadily raised, entered the transformation region, and he demonstrated the thermal effect which accompanies this transformation as later Tool and Eichlin did, and in her last study, Madam Winter Klein. Further, Gillod, using the method of "stereotypage" (freezing in), shows that birefringence appears at the temperature where one encounters a change of refractive index (a reduction thereof) when starting with a glass perfectly stabilized at low temperatures.

In the course of tests we carried out for the present study, we have been able to demonstrate, when working with very homogeneous glass specimens, the difference of density between the surface and the interior during a violent cooling off (air quenching) and during a slow cooling (5° per minute) of specimens 4 x 2 x 2 cm. After stabilizing at a given temperature, the quenched specimen showed a birefringence of 32 millimicrons per centimeter, while that which had been slowly cooled, starting from the same temperature and after an equal period of stabilization, showed no more than 8 millimicrons per centimeter. Using the Preston apparatus ("Sink-Float") we found a difference of "transit temperature" between the interior and the surface of the quenched specimen of 0.12°C., while the difference for the slowly cooled block was no more than 0.04°C. Futhermore, comparing the transit temperatures of these two specimens with those of the standard, we could show that the density of the interior of the quenched specimen is less than that of the slowly cooled specimen which had a little extra time, during its cooling, to pursue its quest for stabilization.

It is obvious that the slower the rate of transformation at the moment of cooling, the less will be the influence of the thermal gradient upon the structural gradient, and in the ultimate analysis on the birefringence, the only criterion at the present day which the glassmaker has about the good or indifferent state of annealing of his glass.

Let us now take up the relaxation curve.

What conclusion can we draw from these curves, and what meaning do they have? In our earlier work, we were able to show that what is needed in the final analysis in order to have a glass free from birefringence, or with very little birefringence at room temperature, is primarily stabilization and not merely a release of stress. Nevertheless, we undertook to carry out a series of tests for the purpose of showing the connection between relaxation at high temperatures and the birefringence found when cold. The details will be published in the second part of this article; but even now we can announce that we find it difficult either to confirm the laws of Adams and Williamson, attractive though they may be, or to establish any simple relation between the relaxation process, the rate of cooling, and the thickness of the specimen.

Could we really expect anything else? It appears to us that we cannot. If we consider the question of relaxation (the lessening of birefringence) at high temperatures in the light of the structural concept and of the facts set forth above, we have to take account of the complexity of the relaxation phenomenon, especially when we know that birefringence is really a difference of two magnitudes and indicates nothing about the absolute value of either.

For our part, we consider that the anisotropy of a specimen of glass in the cold is the outcome of a difference in structural state (i.e., of a structural gradient) between the outer and inner portions of the specimen.

Let us take a specimen which shows a very pronounced birefringence, such as those that we use for the relaxation study, which has been quenched, let us say, from a temperature 100°C. above the transformation temperature.

Given the difference of specific volume between the surface and the interior, the specimen is submitted to a severe mechanical force. On introducing it into a chamber at constant temperature, which is within the transformation range, what is going to happen? The immediate effect that we note is a reduction of birefringence. But there are several reasons for this. The effect of the temperature is to induce a change of structure in the direction of equilibrium corresponding to that temperature: the anisotropy lessens. Under the influence of the forces produced by the difference in specific volume between interior and exterior, a viscous slipping is produced in different layers, but the speed of this movement is difficult to reduce to figures, as it is a function of a force which is diminishing with time and of a viscosity which tends to increase as the structure compacts.

Furthermore, the phenomenon which betrays the anisotropy, namely, the birefringence, is a function of the difference of the indices of refraction for the ordinary and extraordinary rays.

But, as we already know, the index of refraction is itself changing pari passu with the stabilization, and this change is produced in accordance with a law which we do not know and does not seem to us to be a very simple relationship, cf., Kreidl[9] (1950).

In the ultimate analysis, when the sum total of these complex considerations has produced in the hot condition a virtually zero resultant, that is to say, a complete relaxation without any anisotropy remaining, or a net result expressible as so many millimicrons per centimeter, we still know nothing about the state of the glass which has not been defined, and we cannot even predict how it will behave under all circumstances of its later life, for example, in the course of its cooling off.

Let us consider a specific example of a residual birefringence in the hot state of 5 millimicrons per centimeter. According to the temperature at which we operate it is possible to attain this value by any of the following procedures:

539°	*528°*	*519°*	*511°*	*500°*
23 minutes	43 minutes	157 minutes	410 minutes	850 minutes

These correspond, from a structural point of view, to a series of very different states without it being possible to define unambiguously any one of them.

Investigating the matter further, we prepared by various thermal treatments 5 specimens which, in the cold state, all showed substantially the same birefringence, but whose corresponding structural states varied very substantially:

	I	*II*	*III*	*IV*	*V*
mμ/cm	1.4	1.2	1.3	1.0	1.1
density	2.5217	2.5223	2.5230	2.5235	2.5245
% stabilization	51.5	55.5	61.5	66.0	71.5

(*Continued on page* 98)

THE WHY, HOW, AND HOW MUCH OF JOB TRAINING

BY FRED M. CRANDALL, DIRECTOR OF TRAINING
Owens-Corning Fiberglas Corporation, Newark, Ohio

Just what kind of businessmen are you? Would you be interested in an investment that will return 10 or 20% for your money? I hope some of you classify yourselves as "conservatives." I know if you feel that way, you will be willing to listen to the logic that follows and act accordingly. It may well be that there are some "gamblers" among you, too. That is just fine! Any gambler would be interested in the returns he can get from a long-shot like Job Training.

Why Some People Don't Train

Just to be sure that our feet are on the ground and the ideas revolving around in both your heads and mine are similar, let's straighten out a few facts about why people don't train before we get into the reasons why it is a money-saving proposition to have a good Job Training Program. Many people say that they have no Job Training because they do not need it. However, if we recognize the fact that the basic definition of Job Training is "the series of events and experiences which cause a man to perform his job the way he does", we can see that Job Training takes place on every job. The only question then becomes, "Will it be Job Training of an unplanned nature or, since the company must pay for it, are we going to attempt to plan and control this Job Training?"

Many people are *afraid* to tackle a thorough program of Job Training because they don't know how to go about it. That fear shouldn't slow you up because it isn't as difficult as you might think. It is, however, absolutely essential to success that you do a job right. So don't try to take what is often heard described as "the common sense" approach to this problem. Not that "common sense" isn't 100% applicable, but what is usually considered "common sense" is not really the exercise of common sense, but a blissful refusal to investigate and recognize the special facts involved in Job Training while proceeding on the basis of past experience, which does not necessarily have anything to do with the requirements of successful Job Training.

Other people fear to start a program of Job Training because it would "cost too much." Going back to the previous idea the "Training will take place whether it is planned or not", this often-voiced fear of "it would cost too much" becomes not a problem of the cost of Job Training, but a problem of whether or not you are able to plan and control your costs better than you can just let them happen. Quite a few successful businessmen, who have suddenly become happily aware of some of the direct and indirect benefits of a Job Training Program which was instituted with more hope than confidence, have stated that, "Training doesn't cost, it pays!" This is absolutely true and is the only reason that training of all kinds has been slowly progressing throughout the United States and the rest of the world—despite setbacks from ignorant practitioners, people who insisted on the uninformed "common sense" approach, and many ill-advised "economy measures" that tend to kill the goose that lays the golden eggs. But to prove in your own plant that "Training doesn't cost, it pays", it is necessary to make sure that the approach is based upon *training* facts, and that enough time and money are invested to insure the quality of the training applied. Job Training is not a "something for nothing" gimmick that is going to solve all your problems with a wave of some magic wand. It is a sound means of *investment* which will pay exceedingly rich dividends providing it is not watered down to such an extent that all its strength is washed down the drain.

Then there is the "we tried it and it didn't work" school, which hesitates to get into Job Training *again* because they have had one bad experience. To me, that's a little bit like the youngster who refuses to eat just because he once had a tummy ache! You must discover the right thing and use it in the right amount—or you get a tummy ache. I have yet to see a Job Training Program that was properly based, developed and administered that didn't work—and pay back excellent dividends.

Why Job Training Pays

Let's consider the advantages that result from Job Training and make businessmen feel that it is worth the investment. Even the simplest jobs take some time to learn how to do, and some time to work up skill in performance. It can easily be demonstrated that supplying specific and detailed instruction in *what* is to be done, *how* it should be done, *when* it must be done, *who* will do it, and *why* it must be done as instructed, shortens the learning time. (There is seldom any question as to *where* the job is to be done.) A graph of percentage of required knowledge learned or percentage of required skill gained plotted as ordinates against learning time as abscissas will show curves similar to Fig. 1.

This graph is interesting and valuable from several different points. The upper curve shows the learning rate when the individual is carefully instructed in accordance with a well-developed plan which recognizes the fact about how people learn and the level of difficulty of learning various parts of a job. The lower line indicates the results when the individual is given unplanned or unskilled instruction, or merely put on the job and "allowed to learn." The learning time could be expressed

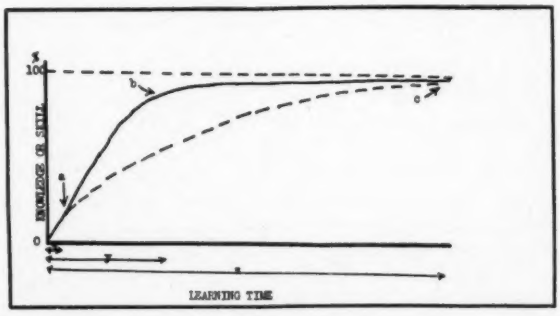

Fig. 1.

Presented before the Twelfth Conference on Glass Problems, University of Illinois, Urbana, Illinois.

on our graph as minutes, hours, days, weeks, months, or even years, depending upon the complexity and difficulty of the job. Three things should be noted:

(1) At the very beginning, up to point "a", learning by plan and learning without plan may be equally rapid. However, while the carefully instructed learner maintains a smooth and rapid increase in percentage of effectiveness the learning rate of the uninstructed or poorly instructed learner falls rapidly.

(2) At point "b" the instructed learner is getting very close to 100% effectiveness. However, the uninstructed learner is still down around 50%.

(3) At point "c", the uninstructed learner has attained the same skill and knowledge as the instructed learner, but note that the time required to come up to qualified rate, "x" compared to "y", is double for the uninstructed learner. These are average sample curves. The one for the instructed learner might not be quite so smooth, and the one for the uninstructed learner almost certainly would show a bumpier advance. Also, while this shows the uninstructed learner getting up to qualified rate in twice the time it takes the instructed learner, it might be it would take only 25% longer or it might take 20 times as long. Generally, the percentages run higher than shown by this graph for jobs of any degree of skill, rather than lower. The shorter learning time involved in instruction by plan is one of the big reasons for installing a good Job Training Program.

A big advantage in adopting a well-planned Job Training Program is that it forces a review of the method of doing the job and eliminates some of the less effective ways. This is not meant to imply that a full-fledged job of work simplification must always be the forerunner of a good program of Job Training. It is most helpful for the man in charge of training to have some knowledge of the laws of motion economy and the principles of work simplification. It is also a big help if you have a staff of industrial engineers who have carefully studied each job, made proper layouts, and determined the exact job methods for accomplishing each activity most effectively. The point to be noted here is that, left to their own devices, a group of workers will usually show considerable individuality in their methods of doing the same job. All of these methods are not as effective for accomplishing a purpose, even considering the fact that different people can do different motions effectively depending upon their own physical and nervous make-up. A careful consideration of the different methods employed by different individuals to do the same job will usually reveal that some of the workers may be making more work for themselves; the methods do not come as near to guaranteeing the desired quality; there is a wastage of material; or there is a greater possibility of injury—to the worker, his fellow workers, or equipment, in some methods.

Reduced turnover is one of the advantages that goes hand in hand with a good Job Training Pragram. Anyone who has given a little thought as to just how much it costs to replace a man on the job, "discovery" costs, hiring costs, extra supervision required until the replacement becomes thoroughly competent, lowered production, wasted material, possible injury to workers or equipment, etc., will realize that each replacement is a very expensive item. If we go back to the learning curve presented before, we can add a few more observations about human beings that are useful. It would take the average of a lot of individuals' learning records to get the nice smooth graph in the figure. Actually, for almost any *individual* case, the graph is full of dips and flat places. These dips and flat places—on the job the foreman sees them as low production or off-quality materials—are very discouraging to the worker. In fact, all he needs to make him decide to try his luck elsewhere is enough of these standstill or retrogressive periods. Without a carefully planned Job Training Program, these incidents are much more likely to take place. The second fact that discourages the individual is that his learning speed may not seem fast enough (his curve doesn't rise at a rapid rate). Many times the foreman will note what seems to him a rate of learning which is too slow. So he is glad to get rid of the slow learner. But, I have often heard experienced supervisors say, "I thought he'd never learn, but now he's the best man I have." If the supervisor gets impatient, either because he doesn't know what a learner's progress should be, or because the learner doesn't progress rapidly enough due to insufficient instructional techniques, he will add to his turnover costs.

While the employee's self-taught method of getting the work out may result in a satisfactory final product, his inability to profit from the past experience of other workers and company in making the most efficient use of materials and supplies can be costly. Take a simple problem that we formerly had in one of our plants. We enclosed some products in large paper bags—the final package weighing more than 30 pounds. The top of the bag was closed by folding it over and running it through a stapling machine. Five correctly spaced staples did a neat and entirely adequate job. The workers in one plant felt that the quickest and easiest way to do the job was to hold the operating pedal down and run the top of the bag rapidly past the stapling point. Unfortunately, even the most skilled operators ended up with unsecure gaps, torn bags, and anything from 8 to 13 staples per bag. Disregarding the general appearance of the package, with an average of 10 instead of the needed 5 staples per bag, at $14,000 annually for staple wire, you can see a nice savings of $7,000 in materials if the job had been done properly. We later started a new plant at which the men were all trained to press the operating pedal 5 separate times. We ended with a good quality package and only 5 staples per package. However, it was very difficult to convince the men who had been in the habit of holding the operating pedal down that they should press it 5 separate times.

"I didn't know you meant that!" is the defensive (and discouraging) whine that one often hears when a worker is being reprimanded for a poor job, or when an expensive accident or misunderstanding is being investigated. In a good Job Training Program, there is no room for misunderstanding. "The instructor continues until he *knows* the learner knows", to put into the terminology of the Job Instruction Training Program which became so widely known during World War II. When this vital habit of checking for understanding is carried over to such simple instruction as, "Bring that to me at 4 o'clock", misunderstanding and misinterpretation of simple instructions is reduced in direct proportion. It is difficult to get supervision at all levels to take the necessary pains to do a good job of instruction, but once a

thorough program has been instituted and lived up to until it becomes habit, costly misunderstandings and mistakes become very few.

No manager with the least spark of a sense of social responsibility can afford to "weigh the chances" of a man doing a job any way but the safest. During the last war the Army Ordnance Department adopted a Job Safety Training Program which enabled them to train hundreds of thousands of inexperienced people in some of the most dangerous work known, and with an extremely low accident record. Much better, in fact, than many industries in which the inherent hazards were not one-tenth as great. Job Safety Training was simply the standard Job Instruction Program with an additional familiarization with hazards and a technique of breaking all safety key points out separately. For the average industry, properly applied Job Instruction Training will cover all safety needs. For the unusually hazardous industry, Job Safety Training develops a greater consciousness of the hazards which may be present in a job. There is no doubt that the technique of hazard spotting incorporated in Job Safety Training can be profitably used in setting up any production method and instructing any supervisory personnel in safety practices.

Many men have tried to develop a way in which that elusive quality known as *morale* can be measured. Everyone agrees that when you've got it you can win against odds, and when you haven't, it makes the going twice as tough. So many factors enter into the matter of morale that no one is quite sure how to establish when it is good and when it is bad. By and large, even the morale surveys are based upon an agreement among men that certain things indirectly indicate a state of good or poor morale. It shouldn't be hard for you to agree that the following end results of a good Job Training Program will result in a higher morale.

(1) The worker *knows* exactly what his supervisor expects of him.
(2) The worker *knows* how he can get the results the supervisor wants.
(3) The worker *knows* why he must do a job in a certain way.
(4) The worker *knows* how to do his job with the least possibility of injury.
(5) The worker *knows* the importance of his job, how it meshes with the over-all efforts of the company, and his hopes for job security.

I have left until last the item which seems to be listed first in most other approaches to this subject. Not that it is any less important, but because so much of it is the result of the items that have been discussed earlier. The last item on my list is *increased production.* If your only problem is to add more people in order to get out a lot more production in a hurry, your speed will be in direct proportion to the quality of your Job Training Program. If your objective is saving money through increased production and by a saving in learning time, decreased waste, etc., all of the above advantages will, in the long run, have the indirect effect of increasing your production for a given amount of time and investment.

Some Advantages of a Job Training Program

(1) Reduces learning time.
(2) Forces adaptation of standard methods.
(3) Reduces turnover.
(4) Improves quality.
(5) Reduces waste.
(6) Reduces misunderstandings.
(7) Reduces accidents.
(8) Improves morale.
(9) Increases production.

Setting Up a Model Job Training Program

We've considered the many advantages of the development of a sound Job Training Program. Now, let's consider how those benefits may best be obtained. In other words, let's get to the "what to do" part of this story. If your company already has an established Job Training Program, you may want to review what is followed with an idea to adapting some parts that may not have been embodied up to this time in your own program. For the company with no Job Training Program at all, the following constitutes a rather complete plan. If your company is a small one, the plan presented can be considered in and of itself a thorough approach. If your company is a large one, it will, of course, be necessary to multiply the number of individuals and jobs concerned a great many times over the indications which follow.

The starting point for any company which plans to make a sound approach to a Job Training Program is the selection of a man who will have over-all responsibility. It isn't necessary that the man have a long and successful experience in training. It isn't necessary that he spend full time in carrying out Job Training activities if your company is a small one, but it is absolutely necessary that some *one* individual be given the ultimate responsibility for setting up, developing, supervising and reporting results of your Job Training Program to management. You cannot win success by depending upon the head of each department to see the job done in his own area of responsibility. In the first place, your company cannot afford to have so many men studying to become thoroughly familiar with all of the techniques and knowledges needed to develop training. In the second place, experience has always indicated that each department head has entirely too many other things pressing for his attention to ever spend enough time to do the job that needs to be done in order to realize a dividend on the company's investment in Job Training. *You* may decide that you are the best qualified to carry through the introduction of Job Training in your company. If you do, resolve now that you will carry through the plan that follows:

The first step in getting a company's Job Training Program underway is the selection of *one* individual who will be responsible for all training activities. Since the success of all the rest of the steps to follow will depend upon this being done properly, his selection should be carefully considered. It would be easy to talk an hour each day on the various factors which should be considered in the selection of your training man. However, we will try to bring all the necessary factors out with only a sentence or two describing the essentiality of this factor in the make-up of the man you select.

Let's take a look at "a few don'ts" first. I've heard of training men chosen because "they were too old for more active work", "they had the knack of getting along with everyone", "there wasn't much else for them to do", "they had outlived their usefulness and we need to give them something to do", "there's no one else avail-

able", and "he did such a good job on that re-organization in the ———————— department." If selection of the new training man is based on such haphazard thinking as this, your money is already down the drain and half the way to the sewer. Let's apply a little more objective thinking before it disintegrates completely.

Your training man needs to be thoroughly mature for two basic reasons: (1) He must gain the respect and cooperation of those who must carry his program through and (2) He must be able to learn a great many new things and develop ways of attacking the problem of helping others learn those things—he has many problems to solve. Other than these reasons, age has little to do with the training man's selection.

Your training men must have a high degree of intelligence. This isn't too difficult. There are standard intelligent tests readily available which are easy to administer and score. One absolute necessity for your training man is that he learn a lot of things, learn them well, see their true applications, and quickly. If at all possible, select a men who can measure at least 90 per cent on one of the well-known intelligence tests. This isn't really so high (I don't care if your company president only measures 70. He probably made his reputation when technical complication and competition both were not as tough as today. People will give *him* time to think and get a job done, but not your training man—at least, not until he has had a few years to establish his training reputation!). Not all "smart" men have the desire to improve and change, however. The training man needs not only intelligence, but a desire to learn, improve and change for the better. This desire to change is more difficult to spot than intelligence, but it can be done if you review the individual's life and habits. Has he made an almost *universal* habit of avoiding change? (Almost all of us have a certain tie, chair, car, or brand of whiskey that we wouldn't change for something a lot better!) Or, does he seem to be generally up-to-date in his appearance, talk, attitude toward changes on the job, changes in society, and the many things with which he surrounds himself.

The training man must have initiative. Since he isn't now a training man, he must get the ball rolling and make himself one. This may be one of his biggest problems. On the other hand, it may be that his biggest problem will be that of overcoming the inertia of other people throughout the company and getting them to make necessary changes. So, he must have the necessary self-starter or he can't succeed. His boss can't help him much, because the boss won't know much about the standards of measurement of progress of your Job Training Program, and he won't know anything about the time and expenditures necessary to bring about results. While it is not expected that the training man have an absolutely free hand, he certainly is going to have to be his own "self-starter" to a very large extent.

To be successful, a training man must be industrious. No one but a successfully experienced training man realizes the tremendous amount of preparation that goes into the make-up of even a small training program. Engineers who complete the installation of a new plant feel that they have labored long and hard, and with great foresight, but in comparison with the time allowed, the help put on the job, and the amount of research that must be done, their job is easy. Since it will probably be some years before management in general realizes what is necessary in the preparation of training and allows sufficient time and personnel to do a job, the eagerness to get a job done which motivates a man to spend his evenings, weekends, and, to some extent, vacations in developing his job will be a necessity.

Your training man must be enthusiastic and the type of man who is able to express and impart his enthusiasm to others. The calm, quiet type can well make progress, but it will be much slower. Probably no other human emotion helps the other fellow "catch fire" as rapidly as does enthusiasm. Nothing else is so contagious. It is one of the essentials in the ability to "sell" another man an idea or a different process of operation.

Good health will be a necessity for your training man. To begin with, it is very difficult for him to show the outward expressions of enthusiasm and drive which are needed to put his ideas across unless he is in good health. Since the pace is hard, as indicated under the ideas of working weekends and vacations, the training man must get along with a minimum of rest. You don't see many older men as successfully practicing training men. Not that it isn't possible to maintain the pace once you have organized the training department, but most men who are past 40 just don't have the energy left to *start*.

Closely allied to the ability to express enthusiasm is the ability to speak effectively and to feel at home speaking to a group. To guide men's actions, it is necessary to communicate effectively. This is usually done, and is certainly most quickly and effectively done, by means of the spoken word. Once again, the quiet, competent type does all right *eventually*, but the need is *now*—there is no time to build up a reputation.

Since a training man must learn to see a great many things that should be changed, and since human beings are prone to resist change, above all, the training man should be tactful. In addition, he must be persuasive in order to get something done about the changes he sees are needed. Not only does a training man need some of the glibness that the uninitiated usually associate with a good salesman, but he needs the salesman's approach to making a sale. Getting someone to accept the idea of doing a job differently, or even merely joining in the study of a job for the purpose of discovering the best way to do it (after all, this insinuates that the man *may not* have everything running *perfectly* now), is selling an idea, which is really a lot harder than selling an auto whose shine, style and zip are something that can be seen and felt.

Tolerance (and an understanding of how people get the way they are) is another essential for successful training. Since he is constantly searching, with special skills in discovering, for possible changes for the better, the training man sees a great many things that "aren't being done right." Many of these things will never be changed, and some of them only after many, possibly bitter, words. In the first place, when we ask a man to change, he must admit that he was wrong before. If not actually wrong, then at least, less than perfect. This isn't an easy thing for a human being to do. One of the measurements of maturity is how easy it is to gain a man's understanding, acceptance and admission that he

should change. If a training man realizes that people (including himself) are this way, he will not think any less of them because "they are slow to come around." Neither will continued defeats of his pet idea make him so discouraged that he won't be able to carry on other worthwhile projects.

A basic, sincere, deep-rooted desire to help others, an interest in others' progress is also one of the requirements for a good training man. Not only will this type of interest enable him to gain the cooperation he must have to be successful in his work, but it will also provide some of the personal rewards that add to his other satisfactions in doing his job. Since there is always the question of whether or not the money compensation is actually enough, the added compensation of feeling that one has helped a fellow human being tends to add up to a much more satisfying job.

Self-confidence — and humility! — are other requirements for the successful training man. Please do not misunderstand my meaning of the word, "self-confidence." Many men who appear to be so self-confident that they become obnoxious to others are not really self-confident. They lack self-confidence. Therefore, they put on a great show of appearing confident and insist upon their own rightness, and rise immediately to defend themselves at the merest hint of criticism. The truly self-confident man does not feel the need to defend himself against criticism. He knows that his reputation is clear despite criticism for some errors of which he might have been guilty. The training man needs the ability to see, accept and do something about his own shortcomings. In the first place, if he is to gain the acceptance of others—their willingness to admit that *they* should do something to improve—he must be quick to recognize the legitimateness of others' criticism of himself. Secondly, he must be alert to the possibility that oftentimes the failure of a program is going to be repeated again and again unless he changes his approach. People are only human beings, and many times "what is right" doesn't mean so much as the habit of years, human inertia, or simple inability. So, it becomes more a matter of changing the approach to a less direct one than merely "what is right" and getting the job done for some other reason. The old theme song of J.I.T., "If the worker hasn't learned, the instructor hasn't taught", may be hard on the instructor, but if he believes in it with all his heart, the training man won't waste time arguing why a program didn't work, but will re-dedicate himself to a new attempt, based on the facts of human relations rather than just "what is right."

Some Factors To Keep In Mind When Selecting A Training Man

(1) Maturity
(2) Intelligence
(3) Adaptability to change
(4) Initiative
(5) Industriousness
(6) Enthusiasm
(7) Good health
(8) Speaking ability
(9) Tact and persuasiveness
(10) Tolerance
(11) Desire to help others
(12) Self-confidence
(13) Humility

Once the training man has been selected, the next step is to qualify him to carry on his job. This cannot be done by letting him proceed on the basis of "common sense" any more than you would set him down in a 4-motored airliner and tell him to get to Los Angeles without delay. Fortunately, the first step to becoming qualified to set up a program of Job Training is neither long, expensive, nor particularly difficult, though an inexperienced man may find that he has to throw many of his dearest prejudices out of the window before he can do it. The first step in qualification is a thorough instituting in Job Instruction Training. There are many consultants who learned this program during the war who would be willing to do this job for you. However, the originators, whom I *know* won't make the learning process so easy as to be ineffective, are available for a very reasonable fee to carry out this essential training (Training Within Industry Foundation, 382 Springfield Avenue, Summit, New Jersey). This training will take only one week, and immediately afterward, your training man is in a position to start training his own instructors and developing his own Job Training Program.

Before leaving the subject of the necessary qualifications of a training man, we should add that he must continue to widen and reinforce his knowledge by constant reading of materials on education, psychology, books on training, current articles on training. He should join the American Society of Training Directors and, by all means, attend local, regional and national meetings as often as possible. Membership in A.S.T.D. means that he not only receives the regular publication of that group, but also that he can draw upon the library of the organization which contains nearly all of the really significant training programs that have been developed in the country during the last several years, and has unlimited entree to other companies for the purpose of discussing their training programs and problems and getting help on his own.

When the head of training has become qualified to instruct Job Instruction Training, he is ready to start the development of the foremen, group leaders, or specially selected men who will act as job instructors in carrying on your Job Training in the various units. The basic fundamentals that these men need to know, together with a very carefully developed program in how to put these things across, is contained in the J.I.T. Institute which your training man should attend. As the training man gains information through his reading and additional contacts in the training field, he will be able to add polish to his training of your job instructors. Departmental supervisors must receive the same ten-hour program in Job Instruction Training that the instructors receive. This is necessary so that they can do their part in building up the program and in maintaining supervision of job methods once the program has been established.

When your job instructors and supervision have received the regular ten-hour J.I.T. Program, it is time to start laying out the instruction job. Of course, your first point of contact will be the experienced workers and supervision in the department in which you are planning your training. If you have industrial engineering and quality control staff departments, these, too, should be contacted and give approval of the final job breakdowns for instructional purposes. Departmental supervision, industrial engineering and quality control join in setting up *what* the instructors are going to teach, *not* how it is going to be done. The best methods of instruction are for the training man to determine. People who know little about the learning process have weird ideas based upon

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PAPER FROM GLASS FIBERS

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

Paper composed entirely of glass fibers, with no additive, has been made for the first time at the Naval Research Laboratory.[1] The all-glass paper—until now considered an impossibility—was developed recently by M. J. O'Leary, J. K. Missimer, J. J. Erving and B. W. Scribner of NBS and T. D. Callinan and R. T. Lucas of NRL. The raw material, commercially available fine glass fibers, was mixed with water and formed into continuous sheets on the semi-commercial papermaking machine in the NBS experimental paper mill. A number of special problems had to be solved, however, before a paper of satisfactory strength and characteristics was arrived at.

The all-glass paper has several important applications. As an air-filter paper, tests at NRL show the new paper to be many times more effective than present commercial filters. It seems particularly valuable for gas masks and respirators used by firefighters, industrial and medical workers, and military personnel. In gas-mask tests in a smoke-filled room, only one smoke particle in 100,000 passed through the glass-paper filter. Until now, many air filters have relied considerably on imported raw materials. Glass, however, can be produced from raw materials found abundantly in the United States.

Another important advantage of the all-glass paper is its high resistance to effects of heat, moisture, chemicals and micro-organisms. It has excellent electrical characteristics[2] and should be valuable as an insulator and dielectric. For instance, it can be used to make oil-impregnated paper capacitors capable of operation even at temperatures above 200°C. Suitable oils are available which withstand such temperatures, but the kraft paper commonly used is unsatisfactory for prolonged operation at temperatures much above 100°C.

Figure 1. The first paper ever made entirely of glass fibers has been produced at the National Bureau of Standards in cooperation with the Naval Research Laboratory. In the first step of the operation, bundles of commercial glass fiber (right) are mixed with 99 parts of water in the beater (center). The new glass paper promises to have great practical value for filters and also as an electrical insulator and dielectric.

Figure 5. The air-resistance of the all-glass paper, here being measured, is an important characteristic in air- and gas-filter applications.

In the manufacture of ordinary paper, vegetable fibers are processed with water in a "beater," which bruises the fibers and forms minute fibrillae. Prolonged beating reduces some of the cellulose to a gelatinous substance that cements the fibers together and strengthens the paper. With glass, on the other hand, bruising tends to weaken the paper and no binding agent is formed.

To get maximum strength and optimum air resistance, the Bureau experimented with different concentrations and beating times. A one-per cent glass concentration in the glass-and-water beater stock gave a stronger paper than higher concentrations, but further dilution had no advantage. Short beating time—just long enough to separate the glass fibers—were best. Weight and thickness of papers having the desired air-resistance varied from 40 to 51 pounds (25 x 40 500's) and from 10 to 14 thousandths of an inch.

The glass-fiber-and-water stock was flowed onto a 29-inch Fourdrinier papermaking machine having a 70-mesh wire 33 feet in length. From the endless-belt wire screen the wet glass-paper sheet passed between special rollers, through a series of driers and onto a reel.

It was found that the wet paper could not be passed through metal rollers without weakening and pinholing. With a cushioning jacket on the first press roll, however, the wet paper was satisfactorily pressed against the felt surface under the paper with minimal injury to the fibers.

Commercial glass fibers of finest diameter—grades of 0.75 micron (about 30 millionths of an inch) or less in size— gave papers with the best strength and filtering characteristics. Other experiments indicate that the strength depends on the presence of fibers of assorted length,

(*Continued on page* 100)

BOOK REVIEW

The Glass Melt, Viewed Microscopically
(Die Glasschmelze mikroskopisch gesehen)

By Hans Jebsen-Marwedel

In a manner recalling his earlier work on defects in glass, Dr. Jebsen-Marwedel has brought out a fascinating and informing series of photomicrographs which show careful choice of significant subjects, excellent photography, and beautiful reproduction. The little book is dedicated to Prof. Turner and Dr. Maurach, both of whom reached age 70 last year. It contains a few pages of introduction, and sections relating to Raw Materials; The Melt; Cords; Surface of the Melt; Bubbles; Knots; Refractory Material; Gall; Devitrification and Paragenesis. In the last section, the most revealing and interesting pictures appear.

The text throughout, including the brief paragraph describing individual pictures, has been made tri-lingual by the inclusion of parallel translations from German into English and French. The English translator has not been entirely accurate. For examples, he has rendered "sauren gase" as "clear bubbles" (p. 25); the apt epithet "lebrig" (livery) for a selenium glass has been omitted (p. 38); he uses the contradictory phrase "in equilibrium with and independent of its surroundings", whereas the original does not mention equilibrium (p. 41); "künstlich" comes out "ingeniously" instead of "artificially", for the insertion of cord centers in a melt (p. 54). However, these are minor blunders in a job well performed.

The photographer has served as a detective, finding visual evidence for phenomena heretofore inferred, such as the incidence of bubbles from pores in the refractory wall, inversions of silica forms, and the concomitant formation of two crystal species in devitrification (paragenesis). The concept of relative dimensions is supplied by a length unit drawn on each photograph. Great skill in "posing" and lighting the subject specimens make the book an artistic as well as a technological contribution, for which Dr. Jebsen-Marwedel deserves our thanks.

Published by the Deutsche Glastechnische Gesellschaft, Frankfurt, Germany, 1951; 6″ x 8¼″; 151 pp.; 130 halftones. S.R.S.

ALL-GLASS BUILDING PLANNED FOR LOS ANGELES

Plans for an all-glass building for Los Angeles, the first of its kind in the west, were announced by George M. Eason, President of the Standard Federal Savings and Loan Association, with the statement that construction will soon begin on the Association's five-story structure.

Totally designed by Welton Becket and Associates, the new building will be a sheer block of glass, with the continuous bands of wide sealed windows alternating with the opaque, gray-blue glass of the spandrels, and only the slender flush aluminum strips of the structural frame interrupting the unbroken surfaces of the glazed facades. The building will be of clear-span construction, obviating the necessity of interior columns, with the use of pre-stressed high-tension steel minimizing the width of the structural beams.

Heat-resisting glass, that reduces by 40% the absorption of solar radiation, will be utilized in all windows, with the glass spandrels well-insulated from behind.

G.C.M.I. NAMES A. F. HUNI AS TRAFFIC DIRECTOR

A. F. Huni, formerly an executive of the New York, New Haven and Hartford Railroad, has been appointed Traffic Director of the Glass Container Manufacturers Institute, according to V. L. Hall, Institute General Manager.

Mr. Huni will join GCMI February 15 to fill the vacancy caused last September by the death of B. H. Taylor, who had been the Institute's traffic executive for many years. In his new position, Mr. Huni will work with the Traffic Committee of GCMI.

Mr. Huni is a native of New Haven, Conn. He joined the freight traffic department of the New Haven road in 1923 and was engaged in rate and statistical duties until 1934 when he was appointed to represent the railroad before the Interstate Commerce Commission and state regulatory bodies.

In 1941 Mr. Huni was named assistant general freight agent and six years later was promoted to general freight agent, which position he held prior to joining GCMI. Mr. Huni will have his headquarters in the Institute's New York office.

B&L PRODUCES OPTICAL GEMS FOR SUN ECLIPSE PHOTOGRAPHS

At Khartoum, Anglo-Egyptian Sudan, specially equipped optical instruments will be focused on the sun's outer rim which will be clearly visible during the three-minute eclipse which will cut a path across middle Africa, but will not be seen in this hemisphere. One expedition of astronomers, sponsored by the Naval Research Laboratory and headed by Dr. John W. Evans of the High Altitude Observatory at Climax, Colorado, is already at Khartoum making preparations for observing the eclipse on February 25.

During the period the sun is completely obscured by the moon, photographs will be made at close intervals through a spectrograph, the most sensitive optical instrument known for detecting minute chemical impurities and capable of identifying elements in amounts as small as one part in 100,000,000. By analyzing photos of the vertical rainbow-like lines of the sun's spectrum, scientists expect to gather more comprehensive data on the sun's elements, its temperature, the density of its atmosphere, radio "signals," and other phenomena.

Two of the spectrographs used by Dr. Evans are equipped with unique "optical gems" known as diffraction gratings. Manufactured especially for the expedition by Bausch & Lomb Optical Company, they replace quartz or glass prisms that are generally used to split light rays into a spectrum according to wavelength.

Measuring six inches long and five inches wide, the surfaces of the gratings are ruled with 135,000 lines—all equally deep, equally spaced, and precisely parallel. The gratings are one inch longer than any previously produced by Bausch & Lomb.

LYNCH ELECTS NEW BOARD CHAIRMAN

At a recent meeting of the Board of Directors of Lynch Corporation, Uz McMurtrie, of Indianapolis, Indiana, was elected Chairman of the Board. Mr. McMurtrie has been active in the affairs of the company since its incorporation in 1923. In 1935 he became a member of the Board of Directors, and was elected a Vice President of the corporation in 1941.

Also at the Board meeting, Richard Henry Werbe was elected to the Board of Directors to fill the vacancy caused by the death of his father, Thomas Chandler Werbe, Sr. Richard Werbe has been affiliated with the various divisions of the Lynch Corporation since 1946 and was serving as assistant to the President at the time of his election to the Board of Directors.

OWENS-ILLINOIS SELLS AMERICAN COATING MILLS DIVISION

J. P. Levis, Chairman of the Board of Owens-Illinois Glass Company, and George E. Dyke, President of Robert Gair Company, Inc., have announced the signing of a contract approved by their respective Boards of Directors providing for the sale by Owens-Illinois of the manufacturing plants, business and inventories of its American Coating Mills Division to the Gair firm on April 1, 1952.

Under the transaction, Robert Gair Company, Inc., manufacturers of paperboard, folding cartons and shipping containers, will acquire paperboard mills at Elkhart, Indiana, and Middletown, Ohio, and carton fabricating plants at Elkhart, Chicago, Illinois, and Grand Rapids, Michigan. In exchange, Owens-Illinois will receive approximately 400,000 shares of common stock of Gair and a substantial cash consideration. Inventories will be purchased for cash. Mr. Dyke said that the Gair company will shortly call a stockholders' meeting to approve the transaction and authorize the necessary additional common stock.

Mr. Levis said that the manufacturing operations of Owens-Illinois, which are devoted to making corrugated boxes for the company's products, will not be included in the transaction.

PETROLEUM ADMINISTRATION WILL NOT SET UP PRIORITY SYSTEM

The Petroleum Administration for Defense has decided against creating a priority system for industrial uses of natural gas as a result of the quarterly meeting of the Gas Industry Advisory Council.

The Petroleum Administration had considered the formulation of a priority system to protect industrial users being supplied on an interruptible basis, but had found it almost impossible to decide the order in which curtailments should occur if they were found to be necessary. It was decided that the industry could do a better job of averting shortages than the government.

AMERICAN GLASSWARE ASSOCIATION ELECTS 1952 BOARD OF GOVERNORS

As a result of recent elections, the American Glassware Association announces the election of the following Board of Governors to serve during 1952: *Governors At Large*, E. A. Donnan, President of Federal Glass Company, and W. L. Orme, President of Cambridge Glass Company; *Alternate Governor At Large*, J. C. Weber, Jr., Vice President of West Virginia Glass Specialty Company; *Division Governors*, Illuminating Glassware, A. S. Tylor, Manager of Lighting Sales Department of Corning Glass Works; Automatic Machine-Made Tumblers, Tableware and Cooking Ware, J. N. McNash, Manager of Tableware Division of Hazel-Atlas Glass Company; Handmade Table, Stem & Ornamental Glassware, T. C. Heisey, President of A. H. Heisey & Company; *Governor for Life*, C. B. Roe, former Chairman of the Governing Board, elected in 1949.

O-C BOARD ELECTS NEW VICE PRESIDENT

The election of John Marshall Briley by its Board of Directors as a Vice President of Owens-Corning Fiberglas Corporation has been announced by Harold Boeschenstein, President of the company.

Mr. Briley left the New York law firm of Shearman & Sterling & Wright, of which he has been a partner since 1940, and started with Owens-Corning on January 1. His headquarters will be in the Fiberglas general offices in Toledo, where he will assume general executive responsibilities, including relationships with foreign and domestic licensees, direction of certain development projects, and formulation of corporate policies.

Mr. Briley has practiced law in New York with Shearman & Sterling & Wright continuously since graduation from the Harvard Law School in 1930. The firm has been special counsel for Owens-Corning Fiberglas Corporation since 1946. Mr. Briley has specialized in corporate finance and international law.

He is a member of the Association of the Bar of the City of New York, the New York State Bar Association, and the American Bar Association.

BRYCE BROTHERS ELECTS CARL KOHL TO PRESIDENCY

Carl C. Kohl has been elected President of Bryce Brothers Company, as a result of a recent meeting of the Board of Directors. Kirk R. Bryce, former President, will assume the position of Chairman of the Board.

Mr. Kohl for the last four years has been Treasurer of Duncan & Miller Glass Company, a position he will resign to join Bryce Brothers. Prior to serving as an officer of Duncan-Miller, Mr. Kohl was staff accountant for Price Waterhouse & Company.

Inventions and Inventors

Feeding and Forming

Paste Mold Machine. Patent No. 2,579,628. Filed Oct. 18, 1945. Issued Dec. 25, 1951. 16 sheets of drawings, none reproduced. Assigned to Kent-Owens Machine Company by Albert F. Tremblay.

This is a machine commonly known as semi-automatic in which a gob of glass is gathered on a blow pipe and placed in the machine which then automatically marvers the gather, places it in a mold which is closed and in which the article such as a lamp chimney or lamp bulb is blown. The mold is rotated and if a paste mold is used, it is dipped in water. The machine includes several novel features and various adjustments to adapt it for making different kinds of ware.

The patent contains 15 claims and nine references were cited: 292,765, Russell, Jan. 29, 1884; 1,124,702, Chamberlin, Jan. 12, 1915; 1,156,858, Chamberlin, Oct. 12, 1915; 1,401,713, Lecoultre, Dec. 27, 1921; 1,410,803, Gray et al., Mar. 28, 1922; 1,497,332, Hartman, June 10, 1924; 1,894,576, Tremblay, Jan. 17, 1933; 2,202,100, Grant, May 28, 1940; and 445,741, France, Sept. 11, 1911.

Glass Compositions

Lead Glass. Patent No. 2,579,709. Filed Sept. 22, 1948. Issued Dec. 25, 1951. No drawings. Assigned to Pittsburgh Plate Glass Company by John J. Smith, James E. Duncan and Harry A. Truby.

These inventors have found that a glass composition containing less than half the customary amount of lead oxide can be given the physical properties normally connected with a high lead oxide content glass by a careful adjustment of the proportions of the remaining constituents of the glass together with inclusion therein of approximately 1% of fluorine.

The following compositions are typical of glasses prepared in accordance with this invention.

Ingredient	Per Cent by Weight 1	2	3
SiO_2	66.95	69.37	66.96
Na_2O	14.74	15.61	14.76
PbO	13.48	10.02	14.48
Al_2O_3	2.88	2.99	2.28
F_2	.96	.99	.96
Sb_2O_5	.99	1.02	None
CeO_2	None	None	.56

These glasses are clear, substantially colorless and plates thereof are readily ground and polished. The glass will have a thermal coefficient of linear expansion of $8.9 \pm .2 \times 10^{-6}$ per degrees centigrade between 25°C. and 300°C. and a maximum softening point of 645°C. These glasses also possess good chemical stability as evidenced by their freedom from opalescence and surface devitrification.

The patent contains three claims and the references cited were 13,766, Macbeth, July 7, 1914; 1,721,979, Taylor, July 23, 1929; and 2,230,199, Dobrovolny, Jan. 28, 1941.

Absorbing Glass. Patent No. 2,581,440. Filed July 3, 1948. Issued Jan. 8, 1952. Two sheets of drawings, none reproduced. Assigned to American Optical Company by Alexis G. Pincus.

This is a glass controlled as to index of refraction, ultraviolet absorption, total energy transmission and visual transmission, and useful particularly for ophthalmic purposes. The patent contains several tables giving in detail the properties of slightly varying compositions. One desirable batch composition is as follows:

Ingredients	Specific Example Parts by Weight	Range Parts by Weight
Silica (SiO_2)	70.3	[1] 67-70
Soda (Na_2O)	6.6	[1] 0-17
Potash (K_2O)	10.7	[1] 0-17
Lime (CaO)	7.0	[1] 4-13
Chlorine (Cl_2)	0.6	[1] 0-1
Sulphur Trioxide (SO_3)	0.6	[1] 0-1.5
Arsenic Trioxide (As_2O_3)	0.4	[1] 0-1.0
Iron Oxides (expressed as Fe_2O_3)	3.6	[1] 1.5-6.5
Vanadium Oxides (expressed as V_2O_5)	0.2	[1] 0.05-0.8

[1] Approximately.

The patent contains 15 claims and the references cited were 2,219,122, Weidert et al., Oct. 22, 1940; 2,226,418, Tillyer et al., Dec. 24, 1940; 2,278,501, Tillyer et al., Apr. 7, 1942; 97,389, Australia, 1924; and 263,410, Great Britain, 1926.

Glass for High-frequency Tubes. Patent No. 2,580,662. Filed March 30, 1949. Issued Jan. 1, 1952. No drawings. Inventor, André Danzin, Paris, France, assignor to Compagnie Generale de Telegraphie Sans Fil, a corporation of France.

This patent has three claims, the last one calling for a glass consisting of

	Per cent
Silicon oxide SiO_2	45-50
Potassium oxide K_2O	8-12
Alkaline earth oxides CaO, BaO, SrO with indifferent relative proportions	30-36
Magnesia MgO	0- 3
Boric oxide B_2O_3	4- 7
Various fluxes	0- 1

The physical properties of this glass are as follows:

Resistivity at 200° C. 10^{13} ohms per sq. cm. per cm.

Temperature for which the volume resistivity of the glass is 100 megohms per sq. cm. per cm.:

$$T_k\ 100 = 452°\ C.$$

Dielectric loss coefficients:

For 1 megacycle ..... $\tan \delta = 12.10^{-4}$

For 10 megacycles ..... $\tan \delta = 7.10^{-4}$

Coefficient of expansion..... 95.10^{-7}
Solubility in water (powder method)..... 28 mgm.

The references cited were 23,049, Armistead, Nov. 23, 1948, and 2,429,432, Stanworth, Oct. 21, 1947.

Glass-to-Metal Seal. Patent No. 2,581,639. Filed Dec. 1, 1950. Issued Jan. 8, 1952. No drawings. Assigned to Pittsburgh Plate Glass Company by J. E. Duncan and J. J. Smith.

This is a neutral gray glass adapted for production of sheet glass in conventional glass drawing machines and capable of sealing directly to a particular chrome-iron alloy. The invention as set forth in Claim 1 is a glass-to-metal seal between an alloy consisting essentially of 83 per cent by weight of iron and 17 per cent by weight of chromium and a glass having an ultimate analytical composition of:

Component	Parts by weight
SiO_2	69.23
Na_2O	16.68
CaO	7.44
MgO	2.67
Al_2O_3	3.04
NaCl	.14
Na_2SO_4	.63
As_2O_5	.05
Fe_2O_3	.10
CoO	.003
NiO	.018

The patent contains three claims and no references were cited.

Neutron-absorbing Glass. Patent No. 2,582,081. Filed Aug. 11, 1950. One sheet of drawings, none reproduced. Assigned to Eastman Kodak Company by Kuan-Han Sun and Thomas E. Callear.

The patent contains four claims, claim 1 being as follows: A neutron-absorbing, optical, borate glass of the system $CdO—InO_{1.5}—BO_{1.5}$ containing by weight as essential ingredients: cadmium oxide, 45 to 69 per cent; indium oxide, 2 to 21 per cent; boron oxide, 28 to 42 per cent, the three said oxides totaling at least 75 per cent by weight.

No references were cited by the Patent Office.

Glass Wool and Fiber

Fig. 1. Glass Mixing Device.

Glass Mixing Device. Fig. 1. Patent No. 2,577,920. Filed Dec. 6, 1944. Issued Dec. 11, 1951. Three sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by R. G. Russell and R. B. Wiley.

This invention is directed particularly to the mixing of a flowing stream of molten glass to be used in the manufacture of fine fibers. A stream of molten glass flows downwardly onto a series of pins arranged so that alternate pins reciprocate horizontally between the fixed pins. The figure shows the fixed pins 26 with the reciprocating pins 29 at one end of the stroke. There may be about nine pins in each group. The reciprocation is fairly slow so that the glass, as it descends, is continually stretched and enfolded, thus practically eliminating any cords.

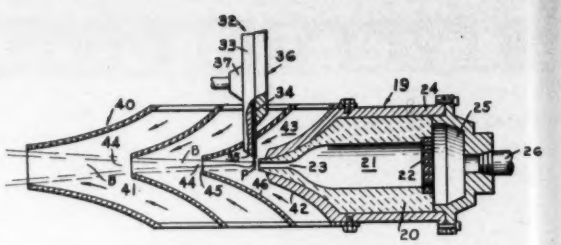


Fig. 2. Glass Fiber Making.

The patent contains three claims and eleven references were cited.

Glass Fiber Making. Fig. 2. Patent No. 2,578,101. Filed Oct. 15, 1947. Issued Dec. 11, 1951. Three sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego.

This invention comprises a burner shown in cross-section in the figure. Fuel from a pipe 26 burns in the chamber 21 where a high temperature and high pressure are generated. Glass filaments P are delivered from guides 36 into the blast from the burner. A temperature of 3000°F. and a velocity of 1,250 or more feet per second have been secured from this burner. The blast discharges through enclosures 40 which cause very fine filaments to be drawn out. These are collected in the usual way.

The patent contains 14 claims and the references cited were 1,128,175, Morf, Feb. 9, 1915; 1,157,984, Herkenrath, Oct. 26, 1915; 1,769,181, Jackson, July 1, 1930; 2,175,225, Slayter, Oct. 10, 1939; 2,402,441, Paddle, June 18, 1946; 2,450,363, Slayter et al., Sept. 28, 1948; 2,455,908, Slayter, Dec. 7, 1948; and 2,499,218, Hess, Feb. 28, 1950.

Furnace for Making Glass Fibers. Fig. 3. Patent No. 2,587,707. Filed Sept. 30, 1947. Issued Dec. 18, 1951. Two sheets of drawings. Assigned to Armstrong Cork Company by Daniel W. Kocher.

This is a method and apparatus for making fibers generally included within the term "mineral wool." The figure shows a section of a chamber containing a pool of molten glass or the like, heated by a burner at one end and at the other provided with a dam 13 and a tube 14 which may be made of a platinum alloy. One end of the tube dips into the glass and the other projects outside the chamber. After the glass has been melted, the chamber is turned into horizontal position as shown and the pressure causes fine fibers to be discharged from the tube.

The patent contains 15 claims and the references cited were 1,326,446, Odam, Jan. 20, 1920; 2,178,871, Drill, Nov. 7, 1939; 2,229,383, Lohse, Jan. 21, 1941; 2,337,072, Tarbox, Dec. 21, 1943; and 2,455,907, Slayter, Dec. 7, 1948.

Sheet and Plate Glass

Manufacture of Thin Sheets. Fig. 4. Patent No.

2,578,986. Filed April 15, 1946. In Netherlands July 6, 1943. Expires July 6, 1963. Invented by Pancras Schoonenberg and Pieter van Zonnevald, Eindhoven, Netherlands, assignors, to Hartford National Bank and Trust Company, Hartford, Conn.

This apparatus is for making glass sheets having a thickness of around 10 microns. The figure shows the bottom 5 of a glass furnace having a slit 10 connecting at the ends with two slotted nozzles 8 and 9. The extruding glass forms two rods 16 and 17 connected by the film 17. The two rods prevent to a large extent the narrowing of the sheet which would otherwise occur. The thin film is later broken from the rods which are discarded.

The patent contains three claims and 10 references were cited.

Miscellaneous Processes

Bottle Testing Machine. Patent No. 2,573,824. Filed Oct. 17, 1946. Issued Nov. 6, 1951. Six sheets of drawings, none reproduced. Assigned to Emhart Manufacturing Company by Theodore C. Baker.

This machine presents a succession of bottles carried by a turret to an inspection head which subjects the bottle to a high-frequency electrostatic field. A rather complicated electrical system is provided by which changes in capacitance starts the operation of an ejector mechanism if the wall thickness of the bottle varies from a predetermined standard. Bottles which pass the inspection go on to the packing table.

The patent contains six claims and the references cited were 2,070,339, Moore, Feb. 9, 1937; 2,270,613, Young, Jan. 20, 1942; 2,285,152, Firestone, June 2, 1942; 2,357,860, Whitaker, Sept. 12, 1944; 2,387,496, Cornelius, Oct. 23, 1945; 2,399,582, Stevens, Apr. 30, 1946; and 2,407,062, Darrah, Sept. 3, 1946.

Quartz Article. Patent No. 2,579,108. Filed May 21, 1949. Issued Dec. 18, 1951. One sheet of drawings, none reproduced. Assigned to General Electric Company by Charles E. Bock and Robert P. Burrows.

This invention is directed particularly to the manufacture of quartz protection tubes used to enclose immersion thermocouples employed in measuring the temperature of molten steel. These inventors have found that the bursting of such tubes in use formerly was caused by the vaporization of water in the capillary ducts normally found in the quartz. This water came from the wet cutting wheel used to sever the glass. The difficulty has been overcome, according to this patent, by glazing a narrow band around the tube at the point to be cut so as to close the capillary ducts before severing at or near the glazed point by the wet cutting wheel. This stops the entrance of water into the ducts and so prevents bursting when in use.

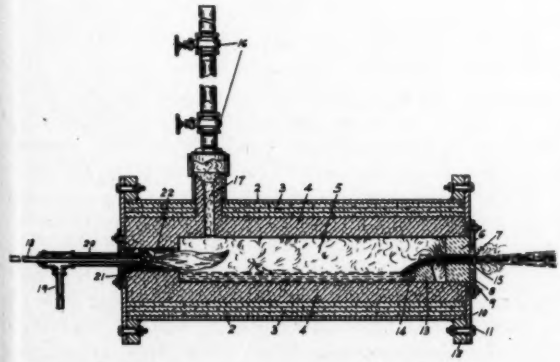


Fig. 3. Furnace for Making Glass Fibers.

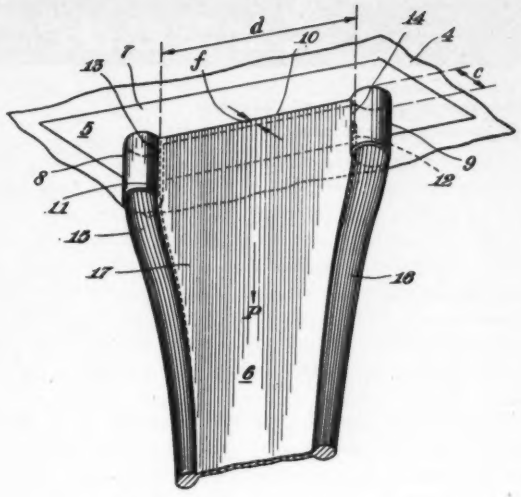


Fig. 4. Manufacture of Thin Sheets.

The patent contains seven claims and the references cited were 761,111, Thomson, May 31, 1904; 1,051,035, Voelker, Jan. 21, 1913; 1,914,205, Hooper et al. June 13, 1933; 1,969,658, McIlvaine, Aug. 7, 1934; 2,436,819, Neidorf, Mar. 2, 1948; 2,459,209, Zagwyn et al., Jan. 18, 1949; and 346,940, Great Britain, Apr. 23, 1931.

Ampul Machine. Patent No. 2,580,658. Filed June 12, 1948. Issued Jan. 1, 1952. One sheet of drawings, none reproduced. Assigned to United Products Co., Inc., by George Coby.

This is a machine for burning off sections from a glass tube, and then bringing a forming tool into contact with the hot glass to form a straight bottom on the ampul or bottle. The apparatus is carried on a turret and the whole operation is automatic. Reference is made to another application for further details of the machine.

The patent contains five claims and the references cited were 2,101,213, Dichter, Dec. 7, 1937; 2,103,585, Kimble et al., Dec. 28, 1937; 2,110,327, Dichter, Mar. 8, 1938; 2,266,417, Eisler, Dec. 16, 1941; and 363,916, Great Britain, Dec. 31, 1931.

Sealing-in Vacuum Tubes. Patent No. 2,581,945. Filed Nov. 27, 1943. Issued Jan. 8, 1951. One sheet of drawings, none reproduced. Assigned to Sylvania Electric Products, Inc., by Robert F. Doran.

This machine is for sealing headers to a glass tube. It discloses a turret type machine in which the header and adjacent tube are heated, sealed and then reshaped by a pair of weighted rollers to produce a smooth cylindrical surface. The apparatus is quite similar to that shown on page 614 of the December issue of THE GLASS INDUSTRY by the same inventor.

The patent contains one claim and ten references were cited.

The Porosity of Tank Blocks: Its Measurement and Variation

The quality of the refractories used in building tank furnaces, or employed in repairs during the run, has a profound effect on the length of furnace life and on the quality of glassware produced. This is true whether the refractories are in contact with the molten glass or are used in the superstructure. It is particularly true of refractories which occur at certain key positions within the tank; for example, in the ports, in the sidewalls or siege, at the throat, as skimmer blocks in the working end, or at forehearth openings.

The constant aim of glass manufacturers is to extend furnace life, to raise the glass quality to the highest possible standard and to make the maximum proportion of good glassware. These goals can only be achieved by choosing, with the greatest care, the refractories that are to be used in or near the key positions and by exercising rigid control of the properties of refractories in all parts of the furnace. It is essential that the desired qualities, once obtained, shall be maintained from one furnace life to the next. How one glass manufacturer has approached this problem is told by Whittaker and Seddon in the August 1951 issue of the *Journal of the Society of Glass Technology*.

After checking and studying various methods of testing refractories, it was decided to measure the porosity of whole blocks before putting them into service. It was therefore necessary to choose a method which would (a) be rapid; (b) be capable of being carried out under working conditions with very simple and robust apparatus; (c) yield an over-all figure for the porosity of the block, however large; (d) not destroy or damage the block; (e) give reasonable accuracy and reproducibility of results.

The method adopted involves the determination of the volume of the block, with a high degree of accuracy, by the use of special measuring gauges and by weighing the block, when dry, in the normal manner. By this means, the over-all bulk density in lb./cu. ft. can be obtained. For a series of blocks of the same type, this bulk density in itself forms a criterion of quality and by determining on a powdered sample the true density of the refractory material, the true porosity can be calculated. In this procedure, the dimensions of the block must be measured as accurately as possible. The errors in porosity, caused by given errors in the dimensions, are shown below (based on an error of 0.05 inch in a dimension, or of 1 lb. in weight):

Variant	Dimensions (Inches)	Volume (Cu. ft.)	Weight (lb.)	Porosity (%)	Error
—	24.00 x 18.00 x 12.00	3.000	450	19.74	—
Length	24.05 x 18.00 x 12.00	3.006	450	19.91	+ 0.17
Breadth	24.00 x 18.05 x 12.00	3.008	450	19.97	+ 0.23
Thickness	24.00 x 18.00 x 12.05	3.013	450	20.08	+ 0.34
Weight	24.00 x 18.00 x 12.00	3.000	451	19.57	— 0.17

The first and most obvious means of control permitted by these measurements of the porosities of tank blocks (nearly all of this work was performed on cast sillimanite blocks) is the segregation of abnormal blocks of very high or very low porosities. It has been the practice of the authors, since 1939, to use such blocks in ways which utilize their particular properties to the best advantage. Blocks with higher porosity may be used in the superstructure, possibly after cutting them to different sizes and shapes; for example, port sills, mid-feather wall tops, or as tuckstones, etc. In such positions, being above the glass level, the high porosity is not detrimental and may even provide somewhat greater spalling resistance during the warming up of the furnace or during reversals. By eliminating such high-porosity blocks, the authors believe that the tendency to throw stones has been reduced (the over-all results support this view), and the danger of the furnace life being limited by the use of an odd-bad block at a key position is very much reduced. Since exercising very careful control of the types and qualities of the refractories at the throat and in the flux lines, etc., stone incidence in the furnaces has been considerably reduced.

It has not been possible to obtain really conclusive evidence of the relative resistance to corrosion offered by blocks with low and high porosities since most of the flux line blocks have only small differences in porosity. Blocks of very high or very low porosity are not put into service or are placed where they can do little harm.

Besides selecting or rejecting blocks on a porosity basis, the blocks are arranged in the furnace walls according to porosity, generally with the lower porosity blocks near the throat, and in order of increasing porosity towards the filling end, but sometimes with lower-porosity blocks under the ports. This system has led to more even wear, an extension of furnace life and a somewhat greater freedom from inclusions in the glass.

By measuring the porosities of thousands of tank blocks, the authors consider that certain advantageous results have been obtained: (1) occasional blocks which are potentially dangerous can be eliminated; (2) the danger of excessive wear at some important key point in the tank furnace can be reduced and subnormally short lives avoided; (3) there is a better chance of reducing inclusions such as stones, cord, drippers, etc.; that is, of reducing the number of off-ware attributable to such causes; (4) a better balanced tank (in the sense of refractories) can be obtained and the possibility of extending lives above normal is improved; (5) with refractories of known and comparable porosities, it is somewhat easier to compare over-all rates of wear at different points in the furnace and thus establish which of these points must be regarded as the most highly stressed; improved design and balance can then be achieved; (6) by studying large numbers of whole blocks, the very real difficulty in sampling refractories is reduced; (7) by means of the somewhat crude yardstick of porosity, we can learn more about refractories and can apply an elementary form of quality controls, determining how the porosity varies from one block to another whether in the same consignment or from different manufacturing sources or between those supplied at different dates.

Current Statistical Position of Glass

Employment and payrolls: Employment in the glass industry during November 1951 was a preliminary 124,800 persons. Compared with the previous month's adjusted employment figure of 128,400, a drop of 2.8 per cent is shown. During November 1950 employment had been 128,800, or 3.1 per cent above November this year.

During November 1951 payrolls were estimated at $35,362,912, which is 2.6 per cent less than the adjusted payroll figure of $36,338,484 reported for October. Payrolls during November 1950 were $37,434,003, which is 5.5 per cent more than for November 1951.

Glass container production, based on figures released by the Bureau of Census, dropped off a little during December to reach 7,602,943 gross. This is 2.5 per cent less than the 7,804,302 gross produced during November 1951. During December 1950 production was 9,357,059 gross, or 18.7 per cent higher than December 1951. At the close of 1951, glass container manufacturers had produced a total of 108,350,872 gross. This annual total is 1.7 per cent above the 106,489,826 gross produced during 1950.

Shipments of glass containers during the last month of 1951 continued downhill and were 7,741,785 gross. Compared with November shipments of 7,925,815 gross, a drop of 2.3 per cent is shown. Shipments during December 1950 were 9,413,143 gross, or 17.7 per cent more than for December 1951. At the close of 1951, a preliminary shipment figure of 114,709,127 gross has been reached which establishes a new second high for shipments of glass containers in a single year. This total is 6.3 per cent higher than the 107,844,224 gross shipped by glass container manufacturers during 1950.

Stocks on hand at the close of December 1951 were 9,452,721 gross. At the close of November there were 9,709,581 gross on hand, and at the close of December 1950, stocks were 6,812,160 gross.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	December 1951
Narrow Neck Containers	
Foods	674,409
Medicinal & Health Supplies	939,582
Chemicals, Household & Industrial	490,001
Beverages, Returnable	522,145
Beverages, Non-returnable	10,219
Beer, Returnable	188,213
Beer, Non-returnable	684,422
Liquors	588,548
Wines	317,812
Toiletries & Cosmetics	458,925
Sub-total (Narrow)	4,874,276
Wide Mouth Containers	
Foods	*1,766,097
Dairy Products	330,387
Medicinal & Health Supplies	278,765
Chemicals, Household & Industrial	82,097
Toiletries & Cosmetics	117,808
Packers' Tumblers	118,973
Sub-total (Wide)	2,694,127
Total Domestic	7,568,403
Export Shipments	173,382
TOTAL SHIPMENTS	7,741,785

* This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production December 1951	Stocks December 1951
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,626,673	3,561,085
	Wide Mouth	*2,147,665	*2,867,725
Dairy Products		291,333	264,563
Beverages, Returnable		540,917	580,153
Beverages, Non-returnable		6,164	16,496
Beer, Returnable		217,739	250,278
Beer, Non-returnable		740,036	540,327
Liquors		591,632	895,996
Wines		323,321	348,456
Packers' Tumblers		117,463	127,642
TOTAL		7,602,943	9,452,721

* This figure includes Home Canning.

Automatic tumbler production during December 1951 continued downward and dropped 2.3 per cent from the 3,889,334 dozens produced during November to 3,799,888 dozens. During December 1950, production was 5,701,631 dozens. Shipments of automatic tumblers also dropped and were 3,352,290 dozens. This is 27.8 per cent below November shipments which were 4,645,353 dozens. During December 1950, shipments were 5,252,988 dozens. Stocks on hand at the close of December 1951, were 11,579,169 dozens. This is 3.1 per cent higher than the 11,228,354 dozens on hand at the close of November. At the close of December 1950, stocks were 9,886,711 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware continued to drop during December 1951 and were reported to be 2,589,424 dozens. This is 23.1 per cent below the 3,368,398 dozens sold during November. During December 1950, sales were 3,218,325 dozens. At the close of the 12-month period ending December 1951, manufacturers have sold a total of 39,139,208 dozens. This is .007 per cent less than sold during the corresponding period ending December 1950.

WYANDOTTE NAMES DEVELOPMENT DIRECTOR

Carl Pacifico has recently been appointed Director of the Development Department of Wyandotte Chemicals Corporation, according to an announcement of Dr. T. H. Vaughn, Vice President of the Research-Development Division. His responsibilities include direction of all the phases of market development and technical service of new organic chemical products.

Prior to assuming this new position, Mr. Pacifico was a member of the Wyandotte field service staff, engaged primarily in the commercial development of applications for Pluronics, Wyandotte's new nonionic detergents, and specialized grades of Carbose.

CALUMITE...

could be the answer

During the past few years, the amber container industry has made rapid strides in quality improvement and high packs. This accomplishment didn't "just happen." It has been the result of clear thinking, well directed energy and plenty of "push."

The industry has reached a point where each additional 1% pack is the real tough one to get and hold—but this same increase represents clear profit—devoid of all overhead.

Users of Calumite have found that a just share of the improvement must be given to this material. Its use has provided higher quality—and more bottles in the carton. An entirely new concept and "know how" for the glassmaking industry has been evolved through the use of Calumite . . . it is one reason for higher packs of better amber ware.

Perhaps some of your production problems could be solved by the use of this high grade, low cost material.

The Calumite Co.
HAMILTON, OHIO

GLASS SCIENTISTS HONOR OTTO SCHOTT

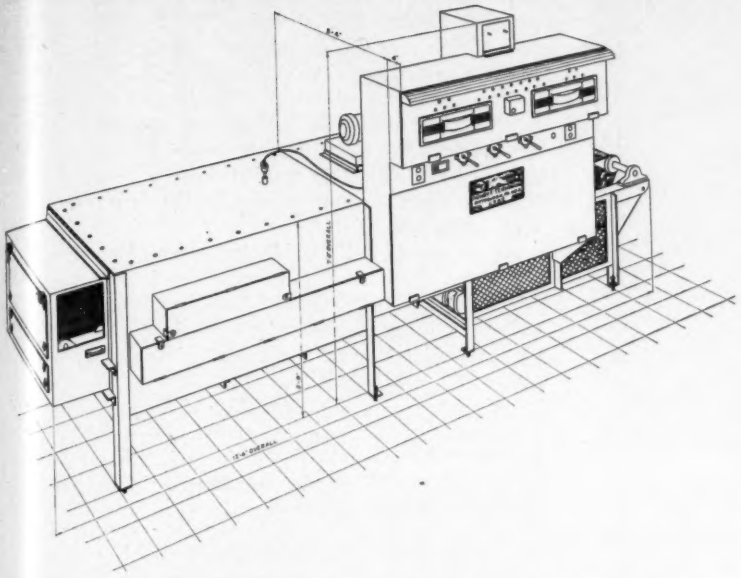
Representative scientists and glass technologists honored the centenary of the birth of Otto Schott (1851-1935), pioneer glass technologist and founder of the world-famed Jena Glass Works Schott & Gen., at a meeting recently held in Witten (Ruhr) in West Germany. The celebration was sponsored by the "Deutsche Glastechnische Gesellschaft" and the City of Witten. Professor Dr. Hans Schimank, of Hamburg, delivered the principal address and called Dr. Otto Schott the "Creator of modern scientific glass technology" in the presence of Dr. Enrich Schott, son of Otto Schott and his successor as head of the firm.

Coming of an old family of glassmakers, Dr. Otto Schott early sought to systematize the technology of glass and to attain a command of the chemistry of non-aqueous melts equal to that already reached with respect to aqueous systems. In this way, Prof. Schimank pointed out, Dr. Schott performed a service to the glassmaking industry and to others dependent upon it paralleling that of Justus von Liebig to agricultural chemistry, Werner von Siemens to electro-technology, Carl von Linde to refrigeration and Rudolp Diesel to internal combustion engines. His great opportunity came through his association with Ernst Abbé, who was already engaged in the firm of Carl Zeiss, Jena, in revolutionizing the science of optics and who recognized the imperative need for special kinds of glasses melted under exact control and not then obtainable to enable him to advance the field of optics. Otto Schott studied at the Institute of Technology in Aachen and the University of Würzburg and Leipzig, and completed his education with a doctorate based on work in "The Theory and Practice of Glassmaking."

An inquiry from the young chemist, Otto Schott, to the eminent Ernst Abbé in 1879 led to the collaboration of these two great men and to revolutionizing the entire glass industry. Schott's original inquiry to Abbé was whether some lithium glasses that he had made might have optical applications and hence value for Dr. Abbé. It turned out that the new glasses were interesting and from that spark of interest grew the scientific development of glass technology that gained a lasting place in industrial history for Otto Schott. Abbé insisted that all of Schott's developments in the plant should be worked out only by way of the laboratory, and so all experimental melts and technical manipulations were subjected to basic scientific study and development. From this practice grew a great mass of scientific information that enabled, even forced, the glass industry throughout the world to discard obsolete and antiquated procedures and to put its operations on a properly scientific basis. Otto Schott's published works and experiments are still proving a gold mine of wide information to glass technologists, and during his lifetime brought him worldwide recognition.

• Armour Research Foundation of Illinois Institute of Technology is offering a number of industrial research fellowships in physics, chemistry, metallurgy, ceramics, engineering mechanics, and electrical engineering to begin in September 1952. Application forms may be obtained from the Office of Admissions, Graduate School of Illinois Institute of Technology, Chicago, Illinois.

New Equipment and Supplies



ELECTRIC ANNEALING OVEN

Henry F. Teichmann, Inc., Investment Building, Pittsburgh 30, Pa., has announced the first shipment of its new electric annealing oven, following some delay in filling orders due to critical material shortage.

Designed and developed solely by Henry F. Teichmann, Inc., the entire structure is self-sustained, of a rigid structural steel frame, and requiring a very small floor space. The special alloy conveyor belt can be fed from the front as well as from the sides. The receiving end is totally enclosed and covered with special adjustable steel curtains to hold the temperature.

The insulation is custom made, and each individual electric heating element is connected to a signal light for the detection of non-operating units. A blower provides, by means of ducts and dampers, negative or positive pressure in the heating, holding and cooling zones. Each temperature zone is controlled by special adjustable steel curtains.

LANGE HEAVY DUTY DIAMOND GLASS CUTTING MACHINE

Henry G. Lange Machine Works, Inc., 166 N. May Street, Chicago 7, Illinois, has announced a new heavy duty diamond glass cutting machine for cutting thick glass and marble accurately and faster than formerly possible.

The new machine will cut corrugated glass any size from the smallest light to full sheets measuring 60″ x 144″, or larger. Angle cuts can be made accurately without chipping. Structural glass of any thickness up to and including ¾″ thick can be cut with a minimum of chipping or breaking away at corners when finishing out. According to the company's statement, grinding is usually unnecessary as the edge is perfectly straight and square. The machine cuts marble slabs up to 1″ thick and plate glass up to 1″ thick from slabs of any size.

CONVERTIBLE MASONRY SAW

Clipper Manufacturing Company, Suite 649, 2800 Warwick, Kansas City 8, Missouri, has introduced a convertible masonry saw, which is actually both a wet (dustless) and dry saw. It can be converted to both a concrete and track saw.

The cutting head of the Model HD masonry saw can be placed on the convertible (4 wheeled) cart. The equipment is then ready for sawing concrete or asphalt patches or trenches. Through such a conversion it is possible to switch from sawing glazed tile, concrete block and fire brick to sewer, water or gas lines and floor patches in a matter of minutes. Fractures from jack hammer operations are now confined within the sawed removal lines, plus the elimination of spalling.

By placing the convertible cart on tracks, a fourth use is accomplished. Stone slabs, transite sheets, pre-cast stone, large refractories, plywood and masonite can be placed under the elevated tracks and sawed with the convertible track saw.

NEW ABBE REFRACTOMETER

Electro-Physics Company, 287 Broadway, New York 7, New York, has announced the availability of a new Abbe refractometer (No. WT-4) which provides very high accuracy readings of index of refraction and average dispersion of liquid, solid and powdered samples. A very small quantity of the substance being measured is required for each reading and the instrument is said to be very easily operated.

In analysis, inspection or research, No. WT-4 provided a simplified method of measuring purity, concentration and the progress of a chemical reaction.

CATALOGS RECEIVED

Kahle Engineering Company, 1307 Seventh Street, North Bergen, New Jersey, has announced the issuance of eleven new pages for inclusion with the Kahle Catalog.

The new sheets are devoted to the following equipment: 48-position automatic exhaust machine with oil-diffusion pumps on every head; bulb tabulating machine for miniature tubes; button stem machine for cathode ray tube stems; automatic neck sealing machine for TV tubes; automatic face plate sealing machine for metal TV tubes; mount sealing machine for large cathode ray tubes; automatic bulb neck crack-off and glazing machine; automatic inside silvering machine for Christmas ornaments; compression type exhaust head for vacuum pumping applications; automatic molded neck sealing machine for vacuum bottles; and automatic lamp base-making machine with automatic cane feed.

Fisher Scientific Company, 717 Forbes Street, Pittsburgh 19, Pa., has issued a 16-page booklet, "The Nefluoro-Photometer," which explains the theory behind three important methods of analysis: colorimetry, fluorometry and nephelometry; and the operation of a new precision instrument combining all three of these techniques in one simple electronic-optical system.

North American Philips Co., Inc., Research and Control Instruments Division, 750 South Fulton Avenue, Mount Vernon, New York, has issued a new 8-page booklet entitled "What is X-ray Diffraction?".

The booklet points out how this analysis method is helping to speed the defense program in identifying components or raw materials to assure uniformity, in identifying unknown materials and constituents of mixtures, and in identifying impurities.

Also covered are the uses in production for selection of raw materials, for production analysis and control, for tracing physical or chemical changes during technological processes, and for checking quality of finished products.

Eberbach Corporation, Ann Arbor, Michigan, has published a new 20-page manual outlining methods for the analysis of copper and lead by electro-analysis.

The methods and extensive bibliography are a product of research at Battelle Memorial Institute.

EXACT WEIGHT Scale checkweighing fiberglas blanket for percentage loss to 1/100 gram after burning —Owens Corning Fiberglas Corp., Newark, Ohio.

Save a Business Life — Yours!

A critical need exists for higher productivity and better cost and quality control to offset steadily rising costs, sharp competition and flimsy profit margins and the need is urgent. Better planning and equipment is needed. High on the priority list of equipment are scales . . . *the right kind in the right place.* For good scales are the very heart of any processing and packaging operation from precision ingredient compounding to final checkweighing of the finished product. No operation today can stand a loss due to failure in ingredient compounding from laboratory procedure through large scale production. No operation can absorb packaging shrink from bulk to finished product. You cannot package even a part of those paper thin profits now. From raw materials to shipping docks alert engineers are pin pointing every spot where adequate weighing units will save money, increase productivity and speed up operation. Saving business lives today is a very active engineering job and no division of EXACT WEIGHT Scales is busier than our own engineering department. Why don't you avail yourself of this know how for your business.

EXACT WEIGHT Scale Model #88-G. Recommended for checking at the hot end. Has convenient carrying handle. Dial markings by 1/16 oz. graduations or 1 gram metric. Weighs accurately on level or out-of-level benches. Capacity to 3 lbs. or 2000 grams metric.

EXACT WEIGHT SCALES

Industrial Precision

THE EXACT WEIGHT SCALE COMPANY

952 W. Fifth Ave., Columbus 8, Ohio
2920 Bloor St., W., Toronto 18, Canada

BALL BROTHERS NAMES NEW GENERAL SALES MANAGER

The latest executive to join Ball Brothers Company in its continuing efforts to decentralize its management, was James L. Knipe, who resigned as Vice President and General Manager of Union Bag and Paper Corporation to accept a similar position with the Ball Brothers firm.

Mr. Knipe's appointment, according to an announcement by Edmund F. Ball, President, was the fourth key appointment the company has made over the last 13 months to provide Ball Brothers with a management of sufficient depth to keep pace with the firm's growth in highly diversified fields.

It was announced that Mr. Knipe would assume direct responsibilities for all sales activities in the glass container fields, both commercial and consumer lines, and will have added functional responsibilities for similar products shipped from the company's southwestern and west coast divisions.

Mr. Knipe's appointment followed by a few days the announcement of the reassignment of G. Fred Rieman from the position as Vice President in Charge of Sales to that of Vice President in Charge of Trade and Industry Relations.

LYNCH APPOINTMENTS

The appointment of Richard H. Werbe as Assistant to the President of Lynch Corporation has been announced by F. K. Zimmerman, President of the firm.

Mr. Werbe has been associated with the Lynch Corporation since 1946, having been connected with the Package Machinery Division for a number of years prior to transferring to the Glass Machinery Division.

It has also been announced that Carl H. Reichert has rejoined the Lynch organization. Mr. Reichert first became associated with the glass industry in 1930 when he was employed by the Miller Machine and Mould Works. When Lynch Corporation purchased that company in 1934, Mr. Reichert was transferred to Anderson, where he was employed as a service engineer. In 1938 he accepted a position with Ball Brothers Company.

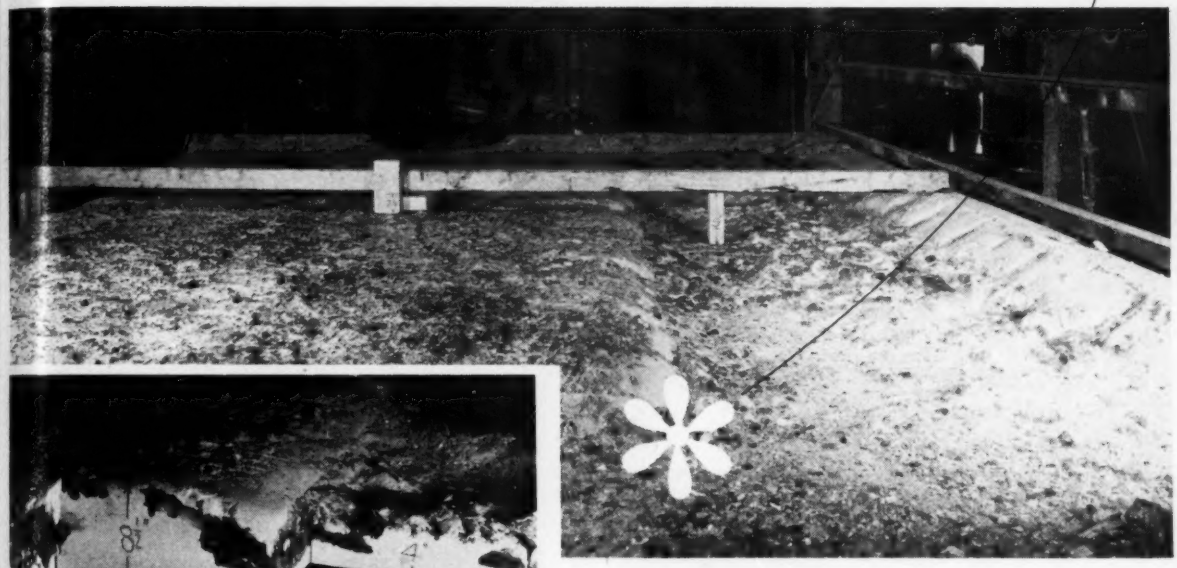
STATUS OF CANADIAN COMPANIES

Dominion Glass Co., Ltd., and its subsidiaries report a net profit of $1,381,019, equal to $5.64 per common share, for the fiscal year ended Sept. 30, 1951 as compared with $1,655,449 or $6.93 per share, for the previous fiscal year. The net working capital amounted to $7,779,420 compared with $7,945,057 in previous year, with current assets being $11,356,686 and current liabilities $3,577,266 as against $10,710,886 and $2,765,829 respectively in the preceding year.

Prospects for the Consumers Glass Co., Ltd., Canada, for 1952 are about the same as in 1951, according to President E. J. Brunning's statement at the annual meeting of stockholders, adding that the company's plant operated at full capacity during the past year and there was no shortage of materials.

Results of operations of the Dominion Glass Co., Canada, for the first quarter are about the same as a year earlier in this period, according to President L. J. Belnap, though the company is now confronted with rising costs of production, including materials, labor, transportation, etc. Company paid in income taxes $1.40 for every $1 per share paid in dividends.

CAST 400 *first* a test:*



Above picture is a view of the edge of the Cast 400 panel and blocks adjacent. Cast 400 block is at left. The even glass contact surface of Cast 400 block points out another of its superior qualities in bottom usage.

The photos above show the bottom of a soda lime container tank, recently shut down.

A nine foot wide by 16½ foot long panel of Cast 400 was installed in the melter bottom from the Dog House forward on the center line of the tank.

After 21 months service Cast 400 had lost no more than one-third of its original thickness at the most severe location. The bottom of this tank was reblocked, of course, with all Cast 400 for the next campaign.

The Laclede service engineer who calls on you will welcome the opportunity of talking with you about longer life in melter bottoms of your tanks.

now...

a complete Cast 400 bottom

Quality First — LACLEDE-CHRISTY COMPANY — FOUNDED 1854

LACLEDE-CHRISTY COMPANY

ARCADE BUILDING • ST. LOUIS 1, MO.

Glass Refractory Division

4705 Ridgewood Ave., St. Louis

Cast Fluxtite • Super Refractory Mix 89 • Fortified Super Refractory Mix 257 • Firebrick and Cements • Silica Brick and Silica Mortar #152

CAST 400

"Application for coverage of the trade mark CAST 400 and its manner of application has been filed with the U. S. Patent Office and an application for patent coverage has likewise been filed in the Patent Office."

R. F. Mensing J. H. Plummer

GLASS FIBERS ANNOUNCES NEW ASSIGNMENTS

Raymond F. Mensing, Vice President and Treasurer of Glass Fibers, Inc., has been assigned additional duties as General Business Manager of the firm, according to an announcement by R. H. Barnard, President. In addition to finance and general accounting, Mr. Mensing will now supervise all purchasing, personnel and sales-production coordination activities for the company. Mr. Mensing joined the glass fiber firm in 1948.

Mr. Barnard also announced the appointment of Jesse H. Plummer, Vice President, as General Factories Manager. His new duties will put Dr. Plummer in charge of all engineering activities and factory operations. Joining Owens-Illinois Glass Company around 1933, Dr. Plummer participated in the early development of the glass fiber industry, then was made chief of the Physics Division in the General Research Laboratory of Owens-Illinois. He joined Glass Fibers in 1947 as Director of Research and was elected Vice President in 1949.

It was also announced that Raymond W. Capaul was elected Vice President and General Sales Manager at a recent Board meeting. Mr. Capaul joined Glass Fibers in 1948 as electrical division manager and was promoted to General Sales Manager in July 1949. F. J. Solon, Jr., who joined the firm in 1947, was elected Vice President-Advertising and Public Relations, Mr. Barnard also announced.

MINERALS FOR GLASS MANUFACTURE FOUND IN ISRAEL

Israel's search for the mineral wealth of the Negev has already resulted in the discovery of sufficient phosphates, Kaolinite and glass sand to cover its needs for 1952, according to a report which appears in *Economic Horizons*, monthly publication of the Economic Department of the Jewish Agency for Palestine.

Phosphates, vital to Israel's agriculture, as well as kaolinite and glass sand for the country's glass and ceramics industries, have hitherto been imported in large quantities. According to Israel Quarries Ltd., a mineral exploration company set up by the Government of Israel last year, the Negev ultimately will yield nearly inexhaustible supplies of salt, clays, sand, limestone, sandstone, dolomite marble, chalk, gypsum and feldspar in a great variety of qualities.

• DESIGN
• ERECTION
• OPERATION

of Glass Plants

DOMESTIC AND FOREIGN

Complete Glass Plants and equipment, Batch Systems, Furnaces, Batch Feeders, "Liberty" Gob Feeders, Automatic Handling Equipment, Stackers, Lehrs, Machines, etc. for manufacture of containers, flat glass, pressed ware, and tubing.

ARTHUR W. SCHMID COMPANY

GLASS PLANT ENGINEERS

INVESTMENT BUILDING, PITTSBURGH, PA.

Cable address: "Schmid" Pittsburgh

another well balanced tank takes shape

This is a side port container glass tank which is gas fired. It's used for melting milk bottle glass and for flint container glass.

THIS TANK USES "MONOFRAX" H
tucks
port bottoms
port jambs
breast walls
bridge wall covers
doghouse mantle
and doghouse arch

"MONOFRAX" MH
throat
sump
side walls
(complete, two-course)
bridgewall
back wall
and doghouse

Every month a growing number of tanks are being made like this one — with a balanced combination of MONOFRAX fused cast refractories. As panel tests are completed, results clearly show these high alumina refractories outwear and outperform any other refractory per dollar invested. This refractory team is job-designed to meet the varied operating conditions existing in different parts of different tanks. Something that no *one* heavy duty refractory can possibly do.

MONOFRAX H material, for example, is ideal for *superstructure* service. Containing over 99% beta alumina it is extremely resistant to high temperatures, heat shock, and chemical reactions. It's very durable, not prone to spall off into the bath.

Type MH is a tank proper material containing over 98% alpha and beta alumina. This combination results in a dense material that is highly resistant to erosion. It's also the purest available refractory (its impurities total less than 0.07%).

Type K is the most joint-erosion resistant material currently available. It's particularly valuable where upward drilling is a problem.

For actual proof, test these materials in your own tanks and superstructures and against all types of glass. The evidence will speak for itself. For further information address: Dept. L-22, Refractories Div., The Carborundum Co., Perth Amboy, N. J.

Fused cast refractories by

CARBORUNDUM

Trade Mark

for long campaigns . . . quality glass

"Carborundum" and "Monofrax" are registered trademarks which indicate manufacture by The Carborundum Company.

JOB TRAINING . . .
(*Continued from page* 79)

personal prejudice or even experience that might have been fine in one isolated instance, but is not applicable as a general rule.

In setting up the training program, look first for needs. If possible, attack first the problems that show easily measurable factors. Be sure to include in all training the reasons why a job must be done in a certain way, information which lets the worker see exactly how the proper performance of his job fits into the over-all objectives of his company, requirements of the customers, and his future possibility of steady employment. Properly detailed and universally agreed upon job breakdowns must be prepared for instruction on each job. The job instructors should never deviate from the program as agreed upon. This last statement does not, of course, preclude the possibility of changes and improvements. While the training job breakdowns will cover the information to be included on the job, when, where, and how the instructor receives the learner, supplementary information he gives him about his job, and how he turns him over to his ultimate supervisor are part of an over-all program which should be detailed between the training man and the instructors, embodying, of course, the best concepts of training and personnel relations which the training man knows.

Once the program is underway it must be properly supervised. You must be certain that the departmental management does not deny time, machinery, or moral support that will make it impossible for even the best instructor to conduct successful Job Training. Likewise, instructors must be constantly supervised to be sure that the old bugaboo of human inertia does not lead them to take the easy way out at times. It is essential that the methods taught be kept up-to-date with changes of all kinds. Once the trainee has demonstrated that he is capable of doing a job right and knows why it should be done that way, it becomes the responsibility of line supervision to keep him "on the straight and narrow." For that reason, it is necessary that the line supervision receive the same training in training methods that the instructors do and that they participate actively in the formation of the methods of work which learners are taught. If the line supervisor does not know, or does not give active supervision to the maintenance of proper work methods after the program has been set up, the job of the instructor quickly degenerates into the rather unpleasant duty of a policeman. The foreman who will permit off-quality work or non-standard methods to be performed right under his eyes, or to pass his control, will quickly neutralize any good which might be possible through your Job Training Program.

That the good results of your Job Training Program, changes in the program, requests for cooperation from management, etc., should be reported back to higher management at a top level goes almost without saying. Management must be convinced that a Job Training Program is worthwhile. Therefore, management must know how it is succeeding.

A Plan For Setting Up A Job Training Program

(1) Select a competent man for over-all responsibility.

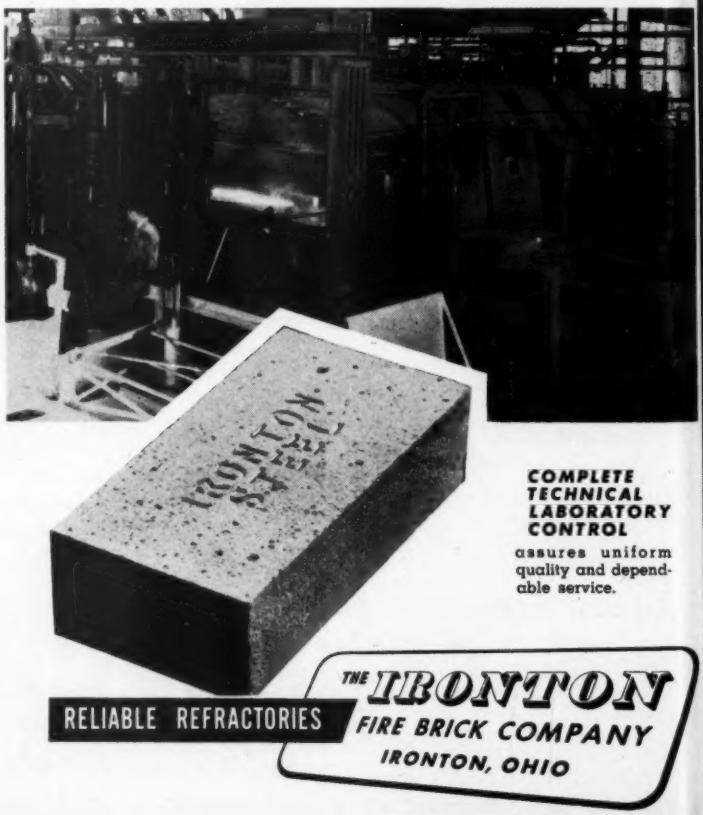
(*Continued on page* 96)

When the order says "First Quality Brick," build regenerating chambers and tank supporting structures *with*

IRONTON STEEL BRICK laid up with ALSET

Engineers in leading glass plants say *Ironton STEEL* Brick is top quality . . . gives economical service on the job. Wherever you need high refractoriness and great structural strength, use *Ironton STEEL*, the reliable brick made of Kentucky flint and semi-flint clay.

Brickwork subject to high temperatures should be laid up with *Ironton* ALSET, the air-setting cement that forms a joint even more refractory than the brick. Write for data or test samples.



COMPLETE TECHNICAL LABORATORY CONTROL assures uniform quality and dependable service.

RELIABLE REFRACTORIES

THE IRONTON FIRE BRICK COMPANY
IRONTON, OHIO

we make the grade

International Caustic Potash, Carbonate of Potash and other related chemicals are available in many grades to meet any or all of your production and processing requirements.

CAUSTIC POTASH (KOH)

...For general usage (chemicals, dyeing detergents, greases, mining, inks, mercerizing, electroplating, etc.)

solid—90%. Available in 700 lb. drums.

flake—90%. Available in 100, 225 & 400 lb. drums.

granular—90%. Available in 100, 225 & 500 lb. drums.

broken—90%. Available in 100 & 450 lb. drums.

liquid, iron free, a sparkling clear water-white solution of 45%. Available in tank cars and 675 lb. drums.

...For soap making

special iron free grade—45 to 50%. Available in 675 lb. drums and tank cars.

...For manufacture of batteries and chemicals where high purity is necessary.

liquid, special low chloride, iron free grade—45%. Available in tank cars and drums.

...For absorption of moisture and CO_2 in air liquifaction

Isco American Selected Walnut—available in 100 and 225 lb. drums.

CARBONATE OF POTASH (K_2CO_3)

...Primarily for the glass industry, but also for fields such as chemicals, pharmaceuticals, soap, textiles, finishing oils, wool scouring, fertilizers, chocolate and dyestuffs.

liquid—47 to 48%. Available in 675 lb. drums and tank cars.

hydrated—83 to 85%. Available in 100 lb. bags and 400 lb. barrels.

calcined—99 to 100%. Available in 100 lb. bags and 325 lb. barrels.

FERRIC CHLORIDE ($FeCl_3$)

...Coagulant for sewage and industrial wastes

lump (crystals)—60% active plus 40% water of crystallization. Available in 500 lb. wooden casks, 300 lb. barrels, and 100 and 200 lb. kegs.

LIQUID CHLORINE (Cl_2)

...For bleaching, in water and sewage treatment, and for manufacture of chemicals, solvents, drugs, etc.

99.7%—Available in tank cars.

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ANOTHER INTERNATIONAL PLANT TO SERVE INDUSTRY

JOB TRAINING . . .
(*Continued from page* 94)

(2) Train that man.
(3) Have him train those who will actually carry out and supervise the instruction.
(4) Break down all jobs for instructional purposes.
(5) Organize the job breakdowns and supplementary handling and information into a Job Training Program.
(6) Supervise the program and the individuals in it.
(7) Report results to management.

The third area of exploration of this presentation is "How Much." This might be interpreted to mean, "How much training shall we use?", or, "How much is training going to cost us?". Let's take a quick look at both. In the matter of time, the safest counsel is not to try to walk before you've crawled. It takes a long time to change the habits of human beings. One of the worst features of the training occupation is that people tend to gain what I call an "intellectual learning" level wherein they agree with everything you say and want to hurry on to something else before the facts or the habit of performing a job in a certain way have become "set" within them. This is less of a problem in Job Training than it is in supervisory training, but you will undoubtedly have your troubles with workers who don't want to practice long enough or with all the energy they should, and with supervision who will want to withdraw learners from training before they are really ready.

Now we come to the costs. To begin with, there are many time costs which must be considered. There is the time of the man to whom you assign the over-all responsibility for the development of training in your company. There is the cost of the time of the supervisory people he will train. There is the cost of the time of the instructors he will train, and who will later do the instruction. There is the cost of the time of the industrial engineering and quality control people who may be consulted in setting up the Job Training Program. Unless you are able to have training done off the job, you will probably have the cost of non-productive time of some of your machinery. There is the learning period time of your trainees.

There are certain direct costs, too. The tuition of your training supervisor, his costs in joining training organizations, attending meetings, and collecting training literature. In addition, there is the cost of equipment you may employ to train your new people and the supplementary training equipment you may keep in your training rooms. It may be that it is possible for the work that they produce to be used 100%, but the chances are good that you will also have some costs for materials and supplies consumed by the trainees which do not get into a salable product.

All in all, those look like some pretty extensive costs, and they are. Whoever holds out the hope that Job Training is a something-for-nothing deal is misleading you to say the least. But businessmen are accustomed to spending money. The entire advancement in this nation's productive welfare has been based upon a willingness to spend money for research and for better tools with which

(*Continued on page* 102)

BORAX

Anhydrous and Technical

• • • One of the original producers of anhydrous borax offers bag or bulk carloads to the Ceramic Industry. Stauffer's Borax is dependable and trouble-free.

TYPICAL ANALYSIS	ANHYDROUS	TECHNICAL ($Na_2B_4O_7 10H_2O$)
Sodium Borate ($Na_2B_4O_7$)	99.25 to 99.50%	52.85 to 54.32%
Boron as B_2O_3	68.00 to 68.89%	36.75 to 37.74%
Chlorides as NaCl	0.10 to 0.16%	0.04 to 0.08%
Iron as Fe	30 to 35 Ppm	2 to 8 Ppm
Arsenic as As_2O_3	20 to 40 Ppm	3 to 8 Ppm
Sulphates as Na_2SO_4	0.3 to 0.4%	nil
Carbonates as Na_2CO_3	nil	nil

•

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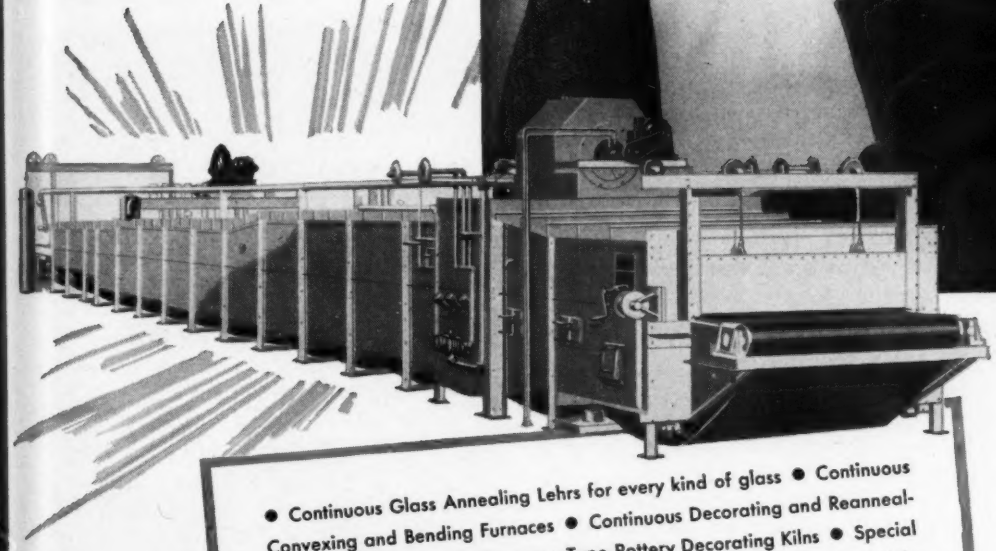

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Surface Combustion CORPORATION
TOLEDO 1, OHIO

(*Continued from page* 74)

Before closing this first part of our study, it seems to us worthwhile to take up once more the consequences of the forces which appear concurrently with the difference of specific volume between the surface and interior of a lump of glass.

We have said that within the transformation range there takes place a relaxation, a re-arrangement partly due to these forces, and in proportion as we approach the lower limit of the transformation range, say some 50 or 60° below the transformation temperature, the rate of relaxation and the rate of stabilization diminish. If we consider the final equilibrium state, this would be attained only in a time theoretically infinite and in practice unrealizable. But this fact in no way implies that there will not be produced any re-arrangement below this temperature even though it may correspond to a stabilization-time virtually infinite.

As we have mentioned above, there exists in a quenched specimen a pronounced difference between the specific volume of the interior and that of the surface, and further that this specific volume is quite different from that which ought to exist at low temperatures or at normal temperatures.

It is clear that such a structure, being in an unstable state, tends, with any rise in temperature, and even at room temperature, towards a re-arrangement which will bring it nearer the state of equilibrium corresponding to the temperature at which it is placed. In our own case, what is involved in a diminution of specific volume, that is to say, a displacement on a molecular scale. But any such displacement involves a resistance to be overcome. Therefore, so long as the forces produced by the lack of equilibrium are greater than the resistance to deformation (using this word in a very broad sense), re-arrangement and relaxation will be produced. But once the two opposing forces have reached equal absolute values, any manifestation of re-arrangement, such as a change of birefringence or a compaction in density, will cease and the glass appears stable although, truth to tell, it is nothing but a pseudo-stability.

A variety of experiments have shown that there is at this moment a sharp arrest in the progress towards stability on the part of the glass.

For example, those of Madam Florinskaya[14] (1948), who carried out tests of relaxation at low temperature (330°C.) for a period of 4½ years; the birefringence at which she ultimately arrived was a function of the initial double refraction. Another test was prolonged at room temperature for 11 years and gave evidence of a deformation indicated by half of a fringe. Plumat[15] (1951) has demonstrated the same fact by measuring the deformation of a test piece which even at the end of a short time ceased to deform, having arrived at a state of pseudo-stability.

By way of curiosity, we have repeated in part the test of Florinskaya at a higher temperature, namely, 470°C., for the borosilicate used in the previous studies, beginning with a birefringence of 295 millimicrons per centimeter. At the end of 6 days we had reached 5.45 millimicrons per centimeter, without being able to observe any further change after 15 additional days.

Translator's note

I have taken the liberty of revising somewhat Dr. Daragan's list of references, since his citations are not all in equally detailed form. I have tried to bring them more nearly into line with the form used by the Royal Society of London, and many biological journals, and some geological ones, in this country. (Taken by and large, the physics journals and ceramic and glass technology journals are behind the times in both countries, and I personally don't like the French ones any better.) I have not been able to do as complete a job of this as I should like, since that would involve changing the method of citing in the text, as well as in the list at the end, and this in turn would involve a more detailed explanation in the text as to why certain references, especially the vast collection listed under reference #4, were cited, and the extent to which they bear on the subject matter, and refute or confirm the author's views. This is beyond the province of a translator, and in the text I have merely added a date after each reference, so as to acquaint the reader with the probable degree of up-to-dateness to be expected in a reference.

In the list itself I have added initials of authors where available, placed date of publication immediately after their names, added titles of their articles when omitted by Dr. Daragan, given volume and page number, but deleted issue number, of journal. I wish to acknowledge the help of Miss Gemperle of this laboratory, and of Mr. Schrero, Technology Librarian of Carnegie Library of Pittsburgh, in the revision. Dr. Daragan has confirmed the correction of the identifications.

I should like to take the liberty of adding one further reference [16]Adams, L. H. (1933) "The annealing of glass as a physical problem," Journal Franklin Institute, *216*, pp. 39-71

This gives Adams' views on the general subject matter after the subject was no longer brand new and time to assess the situation had been given.

LITERATURE CITED

(1) Adams, L. H. and Williamson, E. D. (1920) "Annealing of Glass," J. Franklin Inst., *190* pp. 597-631, 835-70
Tool, A. Q. and Valasek, J. (1920) "Concerning the annealing and characteristics of glass," Bur. Stand. Sci. Paper No. 358
(2) Lebedeff, A. A. (1921) "Polymorphism and annealing of glass," Trans. Optical Inst., Petrograd, *2* pp. 1-18
(2a) Lebedeff, A. A. (1926) "Annealing of optical glass," Rev. d'Optique, *5* pp. 1-30
(3) Winter Klein, N. (1936) "Strain in glass, Part I," Rev. d'Optique, *15* p. 281-
(1937) "Strain in glass, Part II," Rev. d'Optique, *16* pp. 361-85
Winter, A. (1943) "Transformation region of glass," J. Amer. Ceram. Soc., *26* pp. 189-200
(1943) "Structural homogeneity of glass," J. Amer. Ceram. Soc., *26* pp. 277-84
(1944) "Time problem in annealing," J. Amer. Ceram. Soc., *27* pp. 266-74
(1946) "Physical bases of glass annealing," Bull. Inst. du Verre, pp. 3-16
(1948) "Modern evolution of the problem of annealing glass," Verres et Refractaires, *2* pp. 211-21
Lillie, H. R. (1931) "Viscosity of glass between the strain point and melting temperature," J. Amer. Ceram. Soc., *14* pp. 502-11
(1932) "Precise measurements of the viscosities of glasses at temperatures near their annealing points," J. Amer. Ceram. Soc., *15* pp. 418-24
(1933) "Viscosity-time-temperature relations in glass at annealing temperatures," J. Amer. Ceram. Soc., *16* pp. 619-31
(1936) "Stress release in glass—a phenomenon involving viscosity as a variable with time," J. Amer. Ceram. Soc., *19* pp. 45-54
Bailey, J. and Sharp, D. E. (1933) "The release of strain in glass," J. Amer. Ceram. Soc., *16* pp. 367-79
Berger, E. (1932) "Contributions to the theory of glass formation and the glassy state," J. Amer. Ceram. Soc., *15* pp. 647-75
Littleton, J. T. (1934) "The physical processes occurring in the melting and cooling of glass," J. Amer. Ceram. Soc., *17* pp. 43-49
Tool, A. Q. and Eichlin, C. G. (1920) "Absorption of heat in glass," J. Opt. Soc. Amer., *4* pp. 340-63
Tool, A. Q. and Eichlin, C. G. (1925) "Variations in glass caused by heat treatment," J. Amer. Ceram. Soc., *8* pp. 1-17
Taylor, N. W. and Dear, P. S. (1937) "Elastic and viscous properties of several soda-lime glasses in the annealing range of temperature," J. Amer. Ceram. Soc., *20* pp. 296-304

Taylor, N. W. (1938) "The law of annealing of glass: quantitative treatment and molecular interpretation." J. Amer. Ceram. Soc., *21* pp. 85-89
Taylor, N. W. and Noyes, B., Jr. (1944) "Aging thermometers," J. Amer. Ceram. Soc., *27* pp. 57-62
McMaster, H. A. (1945) "Variations of refractive index of glass with time and temperature in annealing region," J. Amer. Ceram. Soc., *28* pp. 1-4
Tool, A. Q. and Eichlin, C. G. (1931) "Variations caused in the heating curves of glass by heat treatment," J. Amer. Ceram. Soc., *14* pp. 276-308
Tool, A. Q. (1942) "An analytical representation concerning glass in its glass annealing range," Extended Abstract, 44th Annual Meeting Program, Bull. Amer. Ceram. Soc., *21* pp. 13-14 (April 15, 1942)
Tool, A. Q. (1946) "Relation between inelastic deformability and thermal expansion of glass in its annealing range," J. Amer. Ceram. Soc., *29* pp. 240-53
Coolyer, P. W. (1947) "Study of time and temperature effects on glass in annealing range," J. Amer. Ceram. Soc., *30* pp. 338-44
Seddon, E. (1938) "Slow changes in the physical properties of glasses," J. S. G. T., *22* pp. 268-308
Balmforth, W. and Holland, A. J. (1945) "The stress-optical coefficient of glasses," J. S. G. T., *29* pp. 111-23
Dale, A. E. and Stanworth, J. E. (1945) "On the viscosity of some glasses in the annealing range," J. S. G. T., *29* pp. 414-27
Franke, K. (1941) "The variation with temperature of the modulus of elasticity of some technical glasses," Glastech. Ber., *19* pp. 113-19
Murgatroyd, J. B. (1948) "The delayed elastic effect in glass fibres and the constitution of glass in fibre form," J. S. G. T., *32* pp. 291-300
Tool, A. Q., Tilton, L. W. and Saunders, J. B. (1947) "Changes caused in the refractive index and density of glass by annealing," J. Res. Nat. Bur. Stand., *38* pp. 519-26.
Jenckel, E. (1938) "Character of the transformation point," Glastech. Ber., *16* pp. 191-95
(5) Daragan, B. (1950) "Contribution to the study of annealing of flat glassware," Verres et Refractaires, *4* pp. 73-82
(5a) Stozarov, A. I. (1928) "The variation of refractive index of glass at high temperatures." Trans. Opt. Institute, Leningrad, *4* Part 39
(6) Gillod, J. (1949) "New interpretation of expansion curves and their application to rational annealing," Verres et Refractaires, *3* pp. 161-72
(7) Douglas, R. W. and Jones, G. A. (1948) "A study of configuration changes in glass by means of density measurements," J. S. G. T., *32* pp. 309-39
(8) Douglas, R. W. (1947) "The relation between the physical properties and the structure of glass. Part I. Variations of the physical properties with time," J. S. G. T., *31* pp. 50-73
(9) Kreidl, N. J. (1950) "The variability of the optical properties and the structure of glass," Glass Ind., *31* pp. 573-75, 598-600
(10) Winter, A. (1950) "Internal stresses in glass," Verres et Refractaires, *4* pp. 341-50
(11) Weyl, W. A. and Pincus, A. G. (1943) "Note on the annealing of glass," J. Applied Physics, *14* pp. 37-39
(12) Gillod, J. Work not published: Conference held at Charleroi, Dec. 11, 1950
(13) Winter, A. *loc. cit.*
(14) Florinskaya, V. A. (1948) "Changes of stresses in optical glass during prolonged annealing," Doklady Akad. Nauk. S. S. S. R., *61* pp. 1039-42
(15) Plumat, E. (1951) "Effect of fast quenching on the characteristic properties of glass," Silicates Industriels, *16* pp. 12-17
(16) Adams, L. H. (1933) "The annealing of glass as a physical problem," J. Franklin Inst., *216* pp. 39-71.

THATCHER ELECTS NEW DIRECTORS AND OFFICERS

The election of two new directors and three new officers of Thatcher Glass Manufacturing Company, Inc., has been announced by Franklin B. Pollock, President.

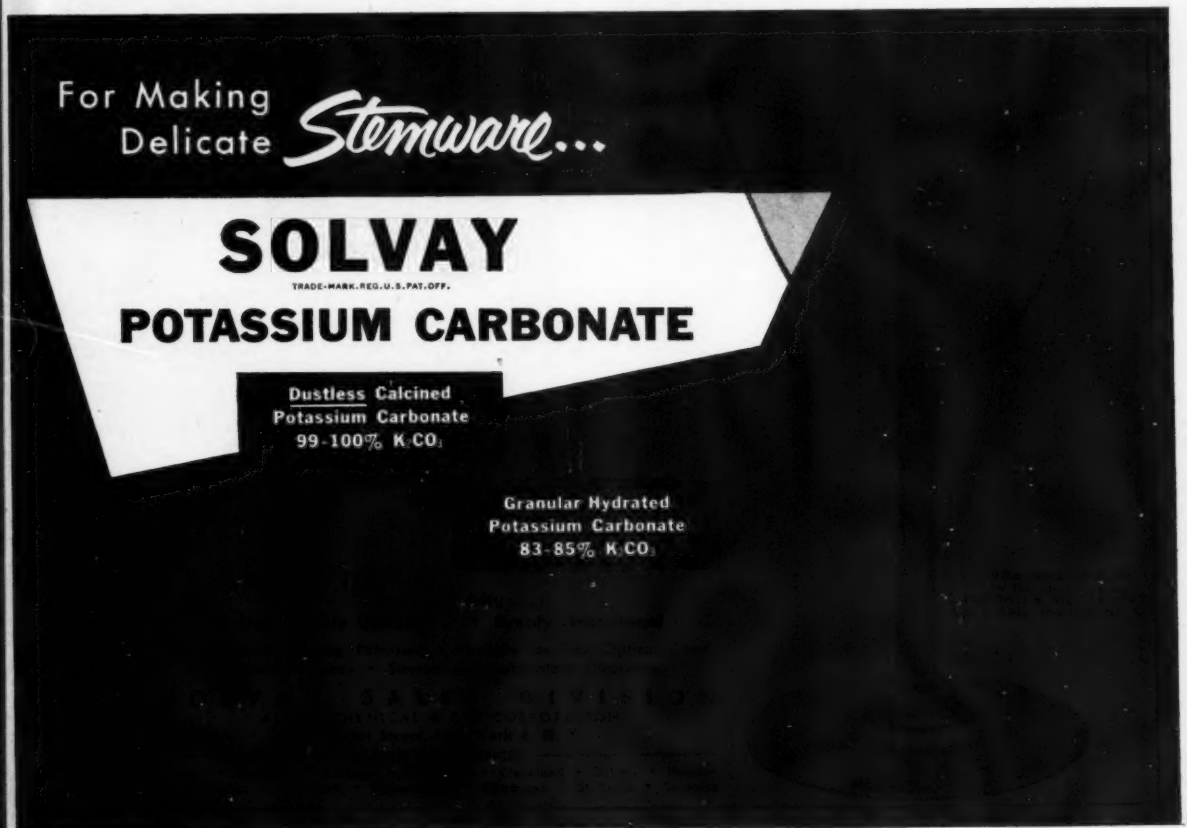
Arch K. Wood, formerly President of McKee Glass Company which recently was merged with the Thatcher company, was elected a Director. W. A. Wood, formerly Vice President of the McKee company, was elected a Director and Vice President in charge of the McKee Glass Division of Thatcher.

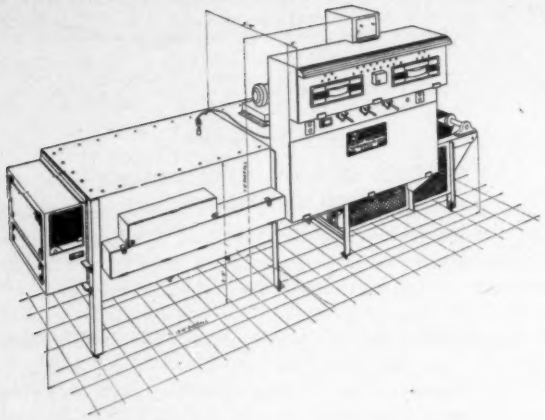
Robert M. DeGarmo was elected Vice President in charge of the production service department, and Reginald L. Burd was elected Vice President in charge of the production engineering department.

EMHART NAMES PARIS MANAGING DIRECTOR

Marshall M. Smith, former Director of the Machinery Division of NPA, has been appointed Managing Director in the Paris office of Emhart Manufacturing Company.

In his new capacity, Mr. Smith will be in charge of European and North African business for all Emhart's operating units, including Hartford-Empire Company's glassmaking machinery activities.





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GLASS FIBER PAPER . . .
(*Continued from page* 80)

but that very short fibers weaken the paper if present in substantial quantities. A sample of the water-fiber mix from the beater was run through a pulp classifier having screens of 65, 100, 150 and 200 mesh. Hand sheets made from fibers retained by the 65-mesh screen had only about one-fourth the tensile strength of the original paper, and hand sheets made from the combination of the 100-, 150-and 200-mesh fibers were even weaker. But when paper was made of a mixture of fibers from all four screens, its tensile strength was 10 times greater than that of the original paper. This remarkable increase in strength apparently resulted from the removal of the "fines" (or "fillers")—the fibers that pass through the 200-mesh screen.

REFERENCES

[1]This development was announced by the Naval Research Laboratory in December 1950. Because of the interest shown in this glass paper by industry, however, the present summary has been prepared to provide more information on the fabrication problems involved.

[2]T. D. Callinan, R. T. Lucas, and R. C. Bowers. The electrical properties of glass-fiber paper, Electrical Manufacturing *48*, 94 (August 1951).

BAUSCH & LOMB APPOINTMENT

Earl Davis has been appointed head of the Glass Development Section of the Chemical Research Laboratory of the Bausch & Lomb Optical Company, according to an announcement from that firm.

Mr. Davis, an Alfred University graduate in Ceramics and a former duPont engineer, was in charge of a glass plant control laboratory of the same company for many years.

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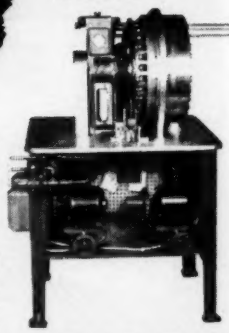

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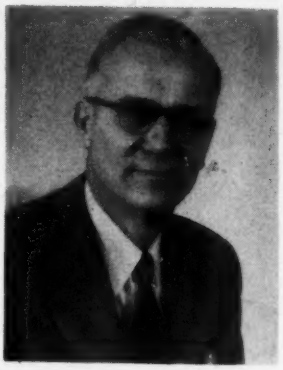
A. P. GREEN NAMES VICE PRESIDENT—SALES

Announcement has been made by A. P. Green Fire Brick Company of the appointment of A. R. Barnett as Vice President in Charge of Sales. Mr. Barnett has been connected with the firm for 28 years and has been General Sales Manager for the past 21 months. Prior to that, he had served the company in sales, manufacturing, shipping and finance.



Mr. Barnett attended the University of Illinois and taught at the Gem City Business College in Quincy, Illinois. He has had broad experience in the operating divisions of A. P. Green Fire Brick Company which qualifies him exceptionally well for his new position.

A. P. Green, founder, is Chairman of the Board of the company. Other Vice Presidents are H. B. Plunkett, L. J. Miller, A. D. Bond, W. G. Staley, N. S. Wood, and R. S. Bradley.

O. HOMMEL APPOINTMENT

The O. Hommel Company has announced the appointment of Ralph A. Kimpton, sales and service engineer, to serve as company representative in the Michigan and Indiana territory.

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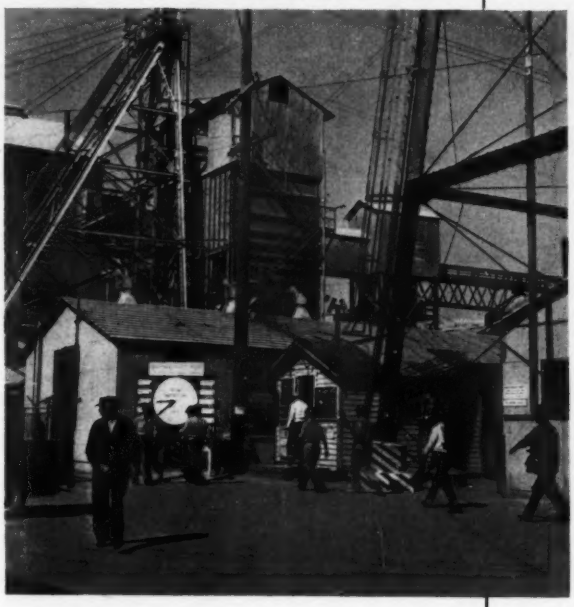

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JOB TRAINING . . .

(*Continued from page* 96)

to work. Training is simply a management tool. Many individuals either do not know how to do the job you want them to do or they are doing it ineffectively at present. Training is the tool to use to make them more productive in the shortest time possible. As in buying a new piece of equipment, you shouldn't "buy" training until you have carefully concluded that it is a tool that it would pay you to use. You should also be cautious that you do not buy training so cheaply (in time and investment) that it will not do the job you want it to. You won't get something for nothing, and the chances are few that you will realize a return on your investment tomorrow. But in the long run, investment in a high-quality, intelligently designed training program will pay about the biggest dividends of any addition your company has ever made. Give yourself a chance.

Costs To Be Considered Before Adopting A Job Training Program

(1) Cost of the training man's time.
(2) Cost of the training man's original training.
(3) Cost of keeping the training man up-to-date.
(4) Cost of training your supervisors and job instructors.
(5) Cost of time in developing your Job Training Program.
(6) Cost of non-productive machinery time if trainees are trained on the job.
(7) Cost of training equipment.
(8) Cost of materials and supplies consumed by trainees.

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GLASS CLUB OF SOUTHERN CALIFORNIA HOLDS MEETING

At a recent meeting of the Glass Club of Southern California, the featured speaker was John Callinan, Manager of the Maywood Branch of Anchor Hocking Glass Corporation.

Mr. Callinan pointed out that glass factory equipment is for the most part well engineered, but in many instances this very expensive equipment is operated by insufficiently trained men. Many production problems are the result of this condition.

Mr. Callinan further pointed out that many production problems can be avoided by "Training on the Job", and he invited discussion from the floor on this subject. Audience participation brought out many interesting conclusions, one of which was that the development of forming machine operators must be continuous rather than intermittent.

• L. E. Durhold has been named Manager of Hemingway Insulator Sales, according to J. P. Kearney, American Structural Products Company, subsidiary of Owens-Illinois Glass Company.

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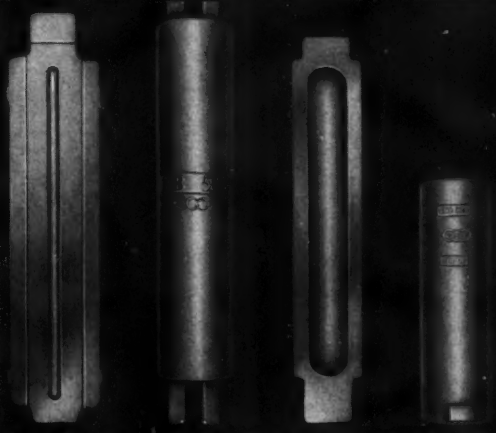
GUNITE

RING STICKS



Ring Sticks are carefully cast to your specifications from your own patterns. Readily machinable.

BAR STOCK

Round bars in standard 14 inch lengths. 1/2 inch diameter to 5 inch diameter by 1/4 inch increments. ALL GUNITE castings are made of Gunite Metal suitably alloyed to provide the ideal glass house material. Gunite Metal is easily machined and readily polished to a mirror finish. Gunite Metal has maximum resistance to heat checking under the severe conditions imposed by glass making operations. You'll get superior service from GUNITE.

PLUNGERS

Standard plungers in all sizes from MG1 to MG10. Easily machined and polished to a mirror finish.

GUNITE FOUNDRIES CORPORATION

ESTABLISHED IN 1854

ROCKFORD GUNITE ILLINOIS